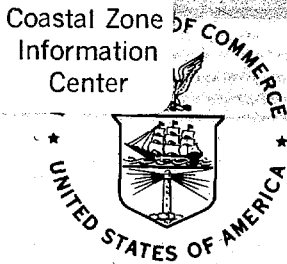


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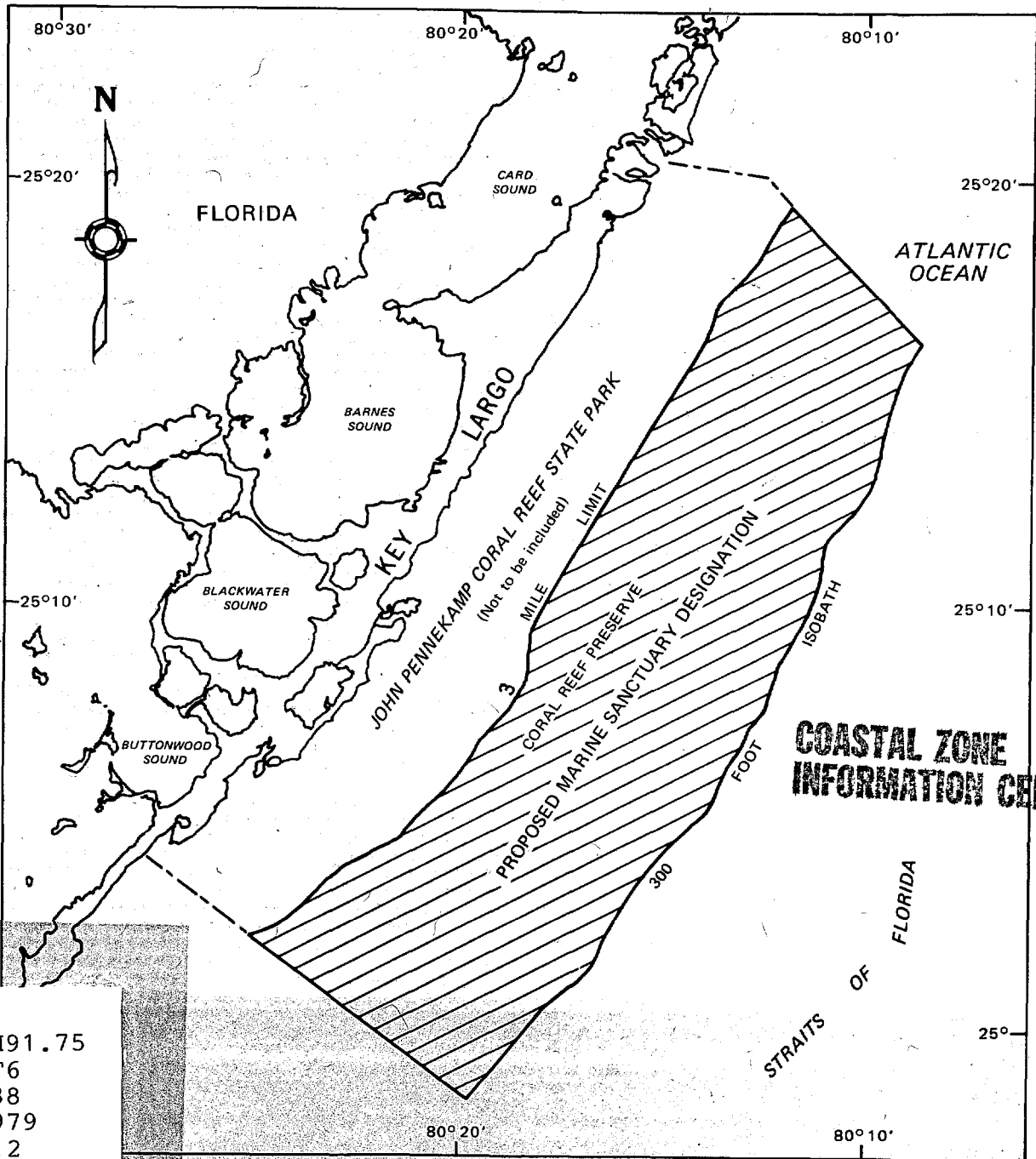


# Key Largo Coral Reef Marine Sanctuary Draft Environmental Impact Statement

August 1975

U. S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
Coastal Zone Management

MAR 3 1976



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AREA OF PROPOSED KEY LARGO MARINE SANCTUARY

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Key Largo Coral Reef Marine Sanctuary

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# Draft Environmental Impact Statement

## Summary

### Key Largo Coral Reef Marine Sanctuary

Responsible Office: NOAA's Office of Coastal Zone Management,  
Rockville, Maryland *20852*

1. Name of Action (X) Administrative
2. Description of Action
3. Environmental Impacts
4. Alternatives

#### 1.0 Project Description

It is proposed to establish a recreational and esthetic area encompassing corals and associated flora and fauna under Title III of the Marine Protection, Research and Sanctuaries Act of 1972. The area will be managed to protect and conserve the coral and coral reef ecosystems, to regulate uses thereof to insure the health and well-being of the coral, and associated flora and fauna, and to make available the continual opportunity for the esthetic and recreational enjoyment which healthy reefs afford the American people. The area nominated is adjacent to but excludes the State of Florida John Pennekamp Coral Reef State Park, beginning at the three-mile territorial limit and extending seaward to the 300 foot isobath (Figure 1). Included in the nominated area is the Key Largo Coral Reef Preserve (Appendix A).

Coordinates for the proposed marine sanctuary are: the point of beginning (POB) is at geographic coordinates 25° (degrees), 19.45' (minutes) north latitude,

80° (degrees), 12.0' (minutes) west longitude, said point being the northeast boundary corner of John Pennekamp Coral Reef State Park. From said POB run thence southeasterly to geographic coordinates 25° (degrees), 16.2' (minutes) north latitude 80° (degrees), 8.7' (minutes) west longitude, said point also being on the 300 foot Isobath, thence run in a southwesterly direction along said Isobath to geographic coordinates 24° (degrees), 58.3' (minutes) north latitude, 80° (degrees), 19.8' (minutes) west longitude, thence leaving said 300 foot Isobath run northwesterly to geographic coordinates 25° (degrees), 2.2' (minutes) north longitude, 80° (degrees), 25.25' (minutes) west longitude, said point being the southeast boundary corner of John Pennekamp Coral Reef State Park, thence in a northeasterly direction along said easterly boundary of said state park to the POB.

### Environmental Setting

#### Biology and Geology

The South Florida coral reef tract is the most extensive reef system of its type in the continental United States. The full reef complex or ecosystem includes a large array of West Indian corals, algae, sponges, shrimp, crabs, lobsters, mollusks, and a host of tropical fish species. The major plant and animal life which includes the most important sediment-producing and sediment-modifying organisms of the coral reefs is provided in Appendix B. The major ecological zones are: (1) rubble, (2) millipora, (3) acropora, (4) open sand, (5) grass beds (primarily thalassia), (6) alcyonarian, (7) reef flat, and (8) back reef. Part of the appendicized information was developed for the Biscayne Bay National Monument. However, the area off Key Largo is very similar, therefore, the information should be applicable. The reef complex of interdependent organisms and its geological characteristics are discussed in Appendix C.

## Uses

The nominated area is currently subjected to a number of commercial and recreational uses. Residents and tourists attracted to the area by the beauty of the reef system participate in the recreational endeavors of boating, sailing, snorkeling, swimming, diving, and sport fishing. A recent aerial survey indicated 260 craft in the area on a single day. The number of visitors to the John Pennekamp State Park for last year was 343,484. Commercial enterprises that supply services for these forms of recreation operate adjacent to the area and within the proposed boundaries.

Other commercial enterprises also utilize the area. Lobster pot fishing occurs. Commercial transportation occurs where water depths permit.

No petroleum resources have been located in the area and no evidence of sand and gravel operations has been identified.

## 2.0 Proposed Management System

### Administration

NOAA's responsibilities under this legislation require that the Office of Coastal Zone Management review, comment and approve any activity that takes place pursuant to the adopted rules and regulations.

Administration of the marine sanctuary will be by the State of Florida, Department of Natural Resources, Division of Recreation and Parks, pursuant to an agreement between the Governor of the State of Florida and the Administrator of the National Oceanic and Atmospheric Administration.

The State of Florida, Department of Natural Resources, Division of Recreation and Parks, will be assisted in administration by an advisory board consisting of representatives of the National Park Service; the

U.S. Coast Guard; Department of Justice; the National Marine Fisheries Service; and the State of Florida's Division of Marine Resources, Division of Marine Law Enforcement, and Department of Environmental Regulation.

#### Proposed Rules and Regulations

Present and proposed future uses of the area include recreational boating and fishing, snorkeling and scuba diving, commercial transport, fisheries activities and scientific endeavors. Those activities allowed within the marine sanctuary, however, will be subject to the following rules and regulations which are intended to provide for the maximum public use consistent with the primary purpose.

#### The Key Largo Coral Reef Marine Sanctuary Proposed Rules and Regulations

##### Categories

1. Removal of or Destruction of Natural Features and Marine Life.
2. Dredging, Filling, Excavating and Building Activities.
3. Refuse and Polluting Substances.
4. Archaeological and Historical Resources.
5. Markers.
6. Fishing.
7. Skin Diving.
8. Operation of Watercraft.
9. Photography.
10. Advertising or Publicity.
11. Explosives and Dangerous Weapons.
12. Closing of the Marine Sanctuary.

13. Report of Accidents

14. Disorderly Conduct

Proposed Rules and Regulations

Prohibited Activities (except by permit or for protection of life, property or the environment.)

(1) Removal or Destruction of Natural Features and Marine Life

(a) No person shall destroy, injure, harmfully disturb or remove beach sand, gravel or minerals, corals, sea feathers and fans, shells and shellfish (except lobster, crawfish and stone crab), starfishes or other marine invertebrates, seaweeds, grasses, or any soil, rock, artifact, stone or other material. Nor shall a person have possession of any of the above listed items in the boundaries of the marine sanctuary regardless of their place of extraction.

(b) No person shall cut, carve, injure, mutilate, move or displace or break off any bottom formation or growth.

(c) No rope, wire, anchor, or other contrivance shall be attached to any coral, rock or other formation, whether temporary or permanent in character.

(2) Dredging, Filling, Excavating and Building Activities

(a) No dredging, excavating or filling operations of any kind are to be carried out in this marine sanctuary. No materials of any sort may be deposited in or on the waters thereof.

(b) No building or structure of any kind, whether permanent or temporary, may be constructed or built.

(c) No public service facility may be constructed or extended into, upon or across this marine sanctuary, with the exception of marking and mooring buoys or stations.

(3) Refuse and Polluting Substances

(a) No person shall dump, deposit or discharge waste material into the waters of this marine sanctuary. Specifically prohibited are wastes, acids, oily liquid wastes or other deleterious chemicals, bottles, broken glass, paper, boxes, dirt, rubbish, waste, garbage, refuse or other debris or substances which shall include the discharge of human sewage.

(4) Archaeological and Historical Resources

(a) No person shall willfully destroy, molest, deface, remove, displace or tamper with any archaeological or historical resources, cargo pertaining to wrecks within the marine sanctuary.

(5) Markers

(a) No person shall willfully mark, deface or damage in any way, or displace, remove or tamper with any signs, notices, or placards, whether temporary or permanent, or with any monuments, stakes, posts or other boundary markers installed by the sanctuary manager or markers for the purpose of lobster pot fishing.

Prohibited Activities

(6) Fishing

Note: Sport and commercial fishing with hook and line for the purpose of taking surface, midwater or bottom fishes (except tropical fishes) and with nets for the taking of surface and midwater fishes, in accordance with the fishing laws of the State of Florida and the rules of the Department of Natural Resources is allowed within the marine sanctuary. The taking of crawfish, spiny lobster and stone crab with traps for commercial purposes, in accordance with the fishing laws of the State of Florida and the rules of the State of Florida Department of Natural Resources, is allowed. All trap floats shall be marked with flags at all times. All traps must be removed from the waters of the marine sanctuary during the closed season.

(a) The use of poisons, electric charges and similar methods for the taking or killing of fish is prohibited.

(b) Any device which is used in violation of the provisions of this subsection is hereby declared a nuisance and may be seized and confiscated to enforce the provisions of this section.

(c) Some portions of the marine sanctuary will be set aside as control areas for research to assist in managing the sanctuary. Those areas designated by the sanctuary manager will be closed to fishing.

(7) Skin Diving

Note: Skin diving for photography and for observation is allowed and encouraged as a compatible and desired use.

(a) Skin divers will not handle corals, stand on coral formations, collect or otherwise disturb corals within the sanctuary.

(b) See 8d below.

(c) See 8e below.

(d) See 8f below.

Prohibited Activities

(8) Operation of Watercraft

(a) All watercraft shall be operated in accordance with Coast Guard rules and regulations. The following additional constraints should also be imposed within the boundaries of the sanctuary.

(b) No watercraft shall be operated in such a manner as to strike or otherwise cause damage to the natural features of the marine sanctuary.

(c) Except in case of emergency situation, where life and property may be endangered, no anchor shall be cast or dragged in such a way as to damage any coral reef formations. Anchors shall be dropped on sand flats off the reefs and placed so as not to drift into the coral formations.

(d) No watercraft shall be operated at greater than 4 miles per hour in the vicinity of divers, sightseeing boats or fishermen, with the exception of law enforcement officials while in the performance of their duties.

(e) All watercraft from which diving operations are being conducted shall fly in a conspicuous manner, the red and white "divers down" flag.

(f) No boat under power shall approach closer than 100 yards to a boat displaying the diving flag except at a maximum speed of 4 miles per hour. Divers shall stay within 100 yards of their diving flag.

(g) Boats anchored or proceeding at slow speeds for fishing or observation shall be approached or passed at such slow speed that the wake of the approaching or passing boat does not disturb the fishing or observation boats.

(h) The operation of all watercraft within this marine sanctuary shall be in accordance with such state and Federal laws as may be applicable to the operation or navigation of watercraft on salt water areas.

Prohibited Activities

(i) Watercraft must use mooring buoys, stations or anchoring areas when such facilities and areas have been designated and are available.

(9) Photography

Note: Photography, both surface and underwater, without the aid of props or cast is encouraged.

(a) No person shall take still or motion pictures either commercial or private, involving the use of special settings or structures, or the performance of a cast of persons, either amateur or professional.

(10) Advertising or Publicity

(a) No person shall erect or cause to be erected, display, or cause to be displayed within this marine sanctuary any signs, slogans or markers.

(11) Explosives and Dangerous Weapons

Note: Distress signalling devices are considered necessary for safe boat operation.

(a) No person shall carry or possess, except while underway through the marine sanctuary or for law enforcement purposes, firearms of any description, air rifles, guns, bows and arrows, slings, spear guns, harpoons, or other kinds of weapons potentially harmful to fish or wildlife or to the reef structure and dangerous to human safety. Use of such weapons within the sanctuary is strictly prohibited.

(b) The use of weapons from beyond the boundaries of this sanctuary and aimed or directed into this sanctuary is forbidden.

(c) The use or possession of explosives within this marine sanctuary is prohibited.

(d) Any weapon or device which is used in violation of the provisions of this subsection is hereby declared a nuisance and may be seized and held pending outcome of legal proceedings.

### Prohibited Activities

#### (12) Closing of the Marine Sanctuary

(a) This marine sanctuary may be closed to public use in the event of emergency conditions endangering life or property. Certain areas may be closed in order to (1) permit recovery of the living resources from overuse, or (2) provide for scientific research relating to protection and management.

#### (13) Report of Accidents

(a) Accidents involving personal injury or damage to property in excess of \$50 shall be reported as soon as possible by the person or persons involved to the sanctuary manager.

#### (14) Disorderly Conduct

(a) Persons who render themselves obnoxious by disorderly conduct or offensive behavior, or who are under the influence of intoxicating liquor, narcotics or habit forming drugs, in addition to being subject to the penalty provision for this section, may be summarily removed from this marine sanctuary.

(b) Violation of any of the provisions of these regulations shall be a civil penalty punishable as provided by the Marine Protection, Research and Sanctuaries Act (16 U.S.Code 14.33).

### Permits

Permits may be issued to conduct educational endeavors, scientific and industrial research, prohibited activities, and recreational activities. Issuance of permits shall be for a limited term and a single activity subject to renewal before expiration of the permit. Permits may be extended at the discretion of the marine sanctuary manager.

A permit application may be filed with the sanctuary manager and shall indicate the purpose, the time period required, describing the proposed

activity including equipment, methods and schedule of events, the financial capability of the applicant to perform the proposed activity, identifying all participants and prior experience in carrying out an analagous endeavor and evidence that all papers required by the United States Coast Guard or any other Federal agency have been obtained.

The applicant will be notified in 30 days whether the permit application has been approved or not approved, and/or whether additional information is required.

An applicant may appeal a denial to the Administrator of NOAA by letter, stating his case and requesting a review of the action of the sanctuary manager.

Permits may be cancelled by the sanctuary manager following notification to the permit holder and after a hearing, if requested by the permit holder.

#### Certification

Once the marine sanctuary has been designated by the Administrator of NOAA, no permit, license or other authorization issued by any other agency shall be valid unless the Administrator of NOAA pursuant to the authority delegated by the Secretary of Commerce, and upon recommendation of the State of Florida, Division of Recreation and Parks as NOAA's administrative officer, and the Advisory Committee, shall certify that the permitted activity is consistent with the purposes of this title and can be carried out within the regulations approved and adopted.

#### Research and Monitoring

Research and monitoring of the effects of particular uses of the coral reef ecosystem will be incorporated into the management procedures as needed to insure that the primary purpose for establishment of the sanctuary is

carried out.

Surveillance of development activities along the coast of Key Largo will be a function of the State of Florida, and the South Florida Regional Planning Council, to insure that these activities do not adversely affect water quality, subsequent health of the coral reef ecosystem, or violate the sanctuary rules and regulations.

#### Enforcement

Implementation and administration of governing rules and regulations for the marine sanctuary will be by the State of Florida, acting in its role as NOAA's contract manager. Pursuant to 14 U.S.C. Sec. 89, the U.S. Coast Guard shall have the responsibility for surveillance and enforcement of the rules and regulations promulgated for the marine sanctuary.

#### Penalties

Any person subject to the jurisdiction of the United States who violates any of the provisions of the governing regulations pursuant to Title III of the Marine Protection, Research and Sanctuaries Act of 1972 (P.L. 92-532, 86 Stat. 1061) will be liable to a civil penalty of not more than \$50,000 for each such violation to be assessed by the Administrator. Each day of a continuing violation would constitute a separate violation. A vessel used in the violation of a regulation promulgated herein would be liable for any civil penalty assessed for such violation and could be proceeded against in the appropriate District Court of the United States having jurisdiction thereof.

#### The Relationship of the Proposed Action to Land Use Plans, Policies and Controls for the Affected Area

This action conforms to the well-established policy of Congress to preserve unique natural resources for their continued use, recreation

and esthetic enjoyment. It also conforms to the evaluation of the general area made in the State of Florida-Florida Keys Coastal Zone Management Study: "The Florida Keys represent a most unique and valuable resource to all of the people of Florida and to hundreds of thousands of tourists each year."

The study also contains the following recommendation: "Implementation of Title III of the Federal Marine Protection, Research and Sanctuaries Act of 1972 to include John Pennekamp State Park as a 'marine sanctuary' in cooperation with the Federal government. Boundaries of the preserve should be enlarged to include the entire fringing reef system."

#### Probable Impact of the Proposed Action on the Environment

Designation of the area as a marine sanctuary and management according to the proposed regulations should control and minimize many of the stresses currently affecting this portion of the Florida reefs. Accordingly, the health and well-being of the reefs and public enjoyment of same should be enhanced.

#### Probable Adverse Environmental (User) Effects

Users of the area will be subject to regulation and some activity will be precluded. The activities to be precluded are spear fishing, damage to the coral and associated flora and fauna, salvage, and souvenir collecting.

If certain areas of coral come under stress owing to intensive use, those areas will be temporarily closed to allow the coral ecosystem to recover; this may cause minor inconvenience. When an area is closed, users will be directed to other areas which should provide an equal experience or level of enjoyment.

The Relationship Between Local Short-Term Use of Man's Environment and the Maintenance of Long-Term Productivity

No irretrievable commitment of resources is involved. The management program proposed is such as to provide for continued, controlled use while retaining open the options for future usage.

Alternatives to the Proposed Action

Four alternatives are considered: no sanctuary, sanctuary with different boundaries, sanctuary with different regulations, and protection under another authority.

No Sanctuary

Should this occur, the current stress conditions that prompted the nomination will continue and the valuable coral resources degraded. In addition, enforcement problems currently experienced in John Pennekamp Coral Reef State Park will continue. This is due to the shallow depths at the State Park Boundary which provide easy entry by anchoring just outside the boundary and diving into the Park. An outer boundary of 300 feet precludes this form of entry without sophisticated diving gear and expertise.

Larger Boundaries

The original nomination proposed larger boundaries. However, the area is bounded on the north by both a ship channel and the Biscayne Bay National Monument. Moreover, the principal reason is the ease of marking a boundary continuous from the State Park and the converse if it is not.

Although arguments could be made for a larger area, it is not necessary in this case for the option for another nomination exists if it becomes evident a larger area is necessary to sustain the ecological balance.

Different Regulations

This would involve either permitting, in the judgment of the nominators,

activities that would stress the coral ecosystem or preclude uses not considered injurious. Although it is felt a proper balance is made in the nomination, modifications may be appropriate. One option is to preclude all bottom fishing. This would impact on those who fish for lobster, crawfish and stone crab. As a minimum, these fishermen would need to travel a much farther distance to set their traps. It is possible that total protection of the species in part of their habitat could result in a greater total abundance in the nonprotected areas. This option would preclude the possibility of damage to the corals by the pots.

Similarly, spearfishing could be allowed. Doing so could increase the possibility of injury to those who use the park and to the coral.

Net fishing could be prohibited, which would eliminate the possibility of coral damage due to net contact with the reefs. However, the reefs do considerable damage to the nets. The costly net repairs and lost fishing time usually make these fishermen very cautious in deploying their nets too close to the reef.

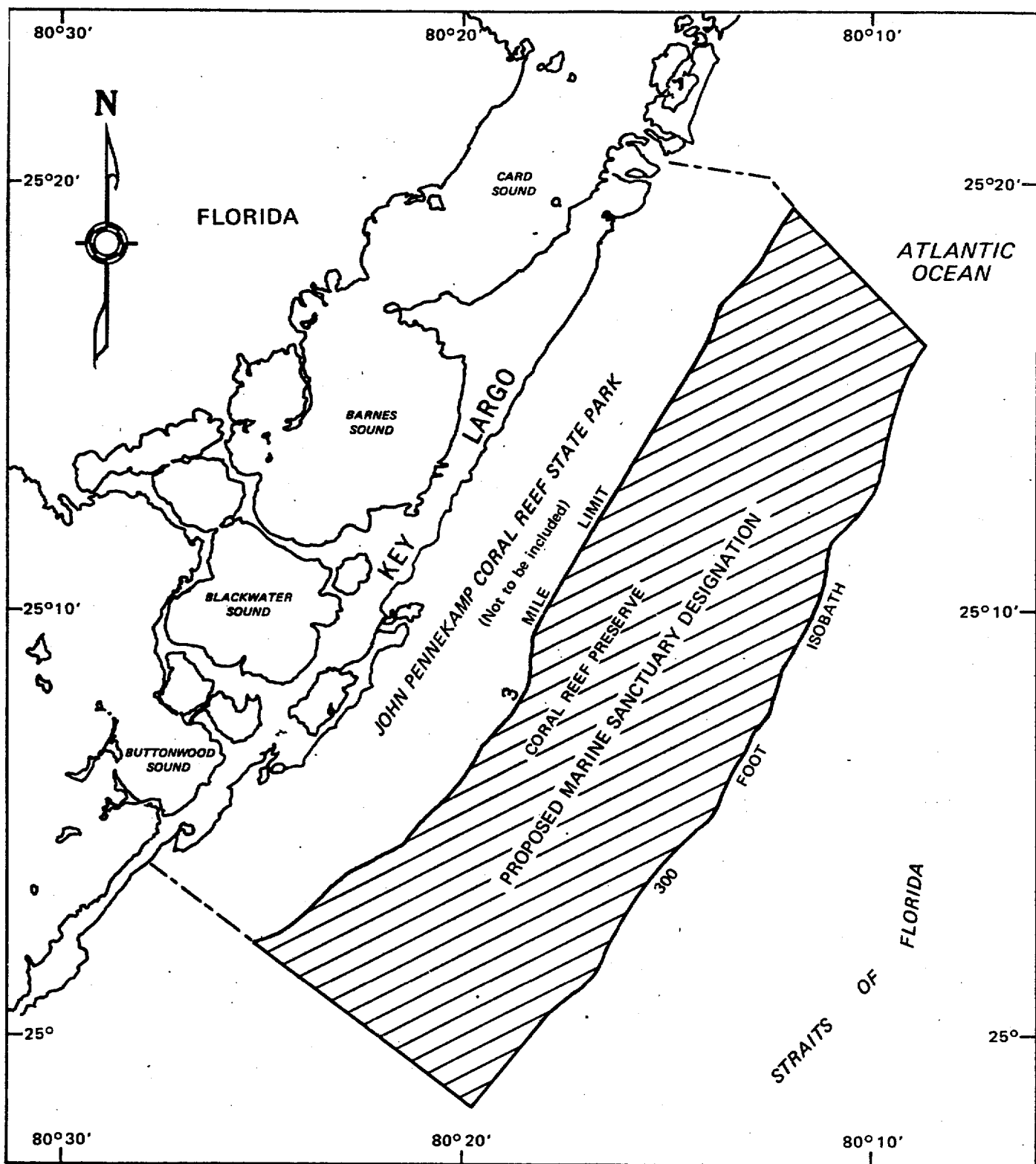
#### Other Authority

Currently no other authority for protecting ~~the~~ living marine resources beyond the three-mile zone exists. The Department of the Interior can set aside areas of the Continental Shelf under provisions of the Outer Continental Shelf Lands Act to conserve our marine mineral resources, but not to protect ecosystems.

Another option is a specific Act to establish the equivalent of the marine sanctuary. This option would accomplish no more than what is proposed under the existing authority of P.L. 92-532, Title III, Marine Sanctuaries.

Coordination

The nomination was circulated to government agencies, industrial organizations and conservation groups and individuals for their review and comment. In addition, a press release was mailed to the newspapers, radio stations and TV stations announcing the nomination. The press release was followed by phone calls to the newspapers of the area most affected to insure the nomination availability, and its content was made known to the residents and users of the area.



AREA OF PROPOSED KEY LARGO MARINE SANCTUARY

FIGURE 1.

## PROCLAMATION NO. 3339

Mar. 17, 1960, 25 F.R. 2352

## ESTABLISHMENT OF KEY LARGO CORAL REEF PRESERVE

WHEREAS there is situated seaward from the coast of Key Largo, Florida, an undersea coral reef formation which is part of the only living coral reef formation along the coast of North America; and

WHEREAS this unique coral formation and its associated marine life are of great scientific interest and value to students of the sea; and

WHEREAS this coral reef is considered to be one of the most beautiful formations of its kind in the world; and

WHEREAS the reef is being subjected to commercial exploitation and is in danger of destruction; and

WHEREAS it is in the public interest to preserve this formation of great scientific and esthetic importance for the benefit and enjoyment of the people; and

WHEREAS a portion of this reef lies inside the three-mile limit in the area

relinquished to the State of Florida by the United States through the Submerged Lands Act, approved May 22, 1953 (67 Stat. 20; 43 U.S.C. 1301 et seq.) [section 1301 et seq. of Title 43, Public Lands], and the remainder lies on the sea bed of the outer Continental Shelf outside the seaward boundary of the State of Florida and appertains to the United States, as declared by the Outer Continental Shelf Lands Act, approved August 7, 1953 (67 Stat. 462; 43 U.S.C. 1331 et seq.) [section 1331 et seq. of Title 43]; and

WHEREAS the United States and the State of Florida are desirous of cooperating for the purpose of preserving the scenic and scientific values of this area unimpaired for the benefit of future generations; and

WHEREAS by the terms of the Outer Continental Shelf Lands Act the United States has jurisdiction over the lands of

the outer Continental Shelf and has the exclusive right to dispose of the natural resources of the sea bed and subsoil thereof; and

WHEREAS section 12(a) of the Outer Continental Shelf Lands Act [section 1341(a) of Title 43] authorizes the President to withdraw from disposition any of the unleased lands of the outer Continental Shelf; and

WHEREAS section 5 of the Outer Continental Shelf Lands Act [section 1334 of Title 43] authorizes the Secretary of the Interior to prescribe rules and regulations for the conservation of the natural resources of the outer Continental Shelf and to cooperate with the conservation agencies of adjacent States in the enforcement of conservation laws, rules, and regulations:

NOW, THEREFORE, I, DWIGHT D. EISENHOWER, President of the United States of America, acting under and by virtue of the authority vested in me by the Constitution and the statutes of the United States, particularly section 12(a) of the Outer Continental Shelf Lands Act [section 1341(a) of Title 43], do proclaim that, subject to valid existing rights, the following-described area is designated as the Key Largo Coral Reef Preserve, and so much thereof as lies on the outer Continental Shelf is withdrawn from disposition:

That portion of the outer Continental Shelf situated seaward of a line three geographic miles from Key Largo, Monroe County, Florida, lying and being within the following described area:

BEGINNING at a point on the 60-foot depth curve (10-fathom line) as delineated on Coast and Geodetic Survey Chart 1249 (approximate Latitude 25° 17' 38" N., Longitude 80° 10' 00" W.), 200 yards southeast of Flashing White Light—Whistle Buoy "2"; thence northwesterly approximately 7,000 yards through Whistle Buoy "2" to Can Buoy "21" (approximate Latitude 25° 20' 06" N., Longitude 80° 12' 38" W.) southeast of Old Rhodes Key; thence southwesterly about 6,000 yards to Can Buoy "25"; thence south-

westerly approximately 5,500 yards to Can Buoy "27"; thence southwesterly approximately 5,000 yards to Flashing Green Light "31BII" in Hawk Channel southeast of Point Elizabeth; thence southwesterly approximately 10,650 yards to Black Day Beacon "33" in Hawk Channel east of Point Willie; thence southwesterly approximately 9,800 yards to Flashing White Light "35" on Mosquito Bank east of Point Charles; thence southwesterly approximately 5,400 yards to Black Day Beacon "37" (approximate Latitude 25° 02' 25" N., Longitude 80° 25' 30" W.), southeast of Rodriguez Key; thence southeasterly approximately 7,100 yards (pass 600 yards southwest of Flashing Light "2" at Molasses Reef) to the 60-foot depth curve (10-fathom line) 800 yards due south of said light at Molasses Reef (approximate Latitude 25° 00' 18" N., Longitude 80° 22' 30" W.); thence northeasterly with the 60-foot depth curve and 10-fathom line (passing easterly of French Reef, Dixie Shoal, The Elbow, and Carysfort Reef) approximately 21 miles to the point of beginning.

I call upon all persons to join in the effort to protect and preserve this natural wonder for the benefit of future generations.

The Secretary of the Interior is requested to prescribe rules and regulations governing the protection and conservation of the coral and other mineral resources in this area and to cooperate with the State of Florida and its conservation agencies in the preservation of the reef.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the Seal of the United States of America to be affixed.

DONE at the City of Washington this fifteenth day of March in the year of our Lord nineteen hundred and sixty and of the Independence of the United States of America the one hundred and eighty-fourth.

[seal]

DWIGHT D. EISENHOWER

#### Library References

Armed Services ◀54.  
Woods and Forests ◀8.

C.J.S. Army and Navy § 107.  
C.J.S. Woods and Forests §§ 11, 12.

A LIST OF FISHES OF ALLIGATOR REEF, FLORIDA  
WITH COMMENTS ON  
THE NATURE OF THE FLORIDA REEF FISH FAUNA<sup>1</sup>

Walter A. Starck, II  
Institute of Marine Science, University of Miami

Abstract

The fish fauna of Alligator Reef, Florida is enumerated and the zoogeographic nature of the Florida reef fish fauna discussed. A total of 517 species are recorded, of which 389 are coral reef forms. Forty-five species are previously unknown from Florida and an additional eight are undescribed. The Alligator Reef fish fauna is now the richest known of any single location in the new world. Only seven of the reef species are not recorded from elsewhere in the West Indian region outside Florida and this number is expected to be further reduced with additional collecting in other areas. The Florida reef fish fauna is believed to be composed of post-glacial immigrants from the West Indies and Yucatan.

INTRODUCTION

Coral reefs, though harboring what is probably the richest and certainly one of the oldest and most stable animal communities on earth, have been relatively little studied. The tremendous potential for biological research offered by coral reefs has been offset by their remoteness from most centers of higher learning and by their being underwater. In recent years development of marine research institutions in tropical regions, advances in various fields of technology, and increased availability of funds for marine biological research have resulted in a considerable increase in work on coral reefs.

The West Indian coral reef fauna in general, and that of Florida reefs in particular, are better studied than reef faunas elsewhere in the world and of reef animals fishes are among the best known. In the present list the presence of 45 species of reef fishes previously unrecorded from Florida or other U.S. waters and at least eight undescribed species is indicative of the inadequate state of our knowledge of even the best known reef organisms in the most thoroughly studied region. An additional indication of the status of our information is the fact that 36 species in the list have been described since 1955.

Even among described species many systematic problems remain and beyond the systematic level very little information is in print regarding the biology of most reef fishes. To an important extent in coral reef studies we are still dealing with an unknown fauna. This list constitutes what is apparently the first reasonably definitive enumeration of a coral reef fish fauna.

The present paper is the second of a series dealing with the structure of the fish fauna of Alligator Reef (the first is Starck and Davis, 1967). Future publications on color patterns, size and form, habitats and species associations, general behavior, and other aspects of reef fish biology are in preparation.

<sup>1</sup>Contribution Na 890 from the Institute of Marine Science, University of Miami

## STUDY AREA

Alligator Reef is a shallow knoll on the Florida reef chain located about 3.5 nautical miles offshore of the town of Islamorada Florida, in the Florida Keys. The area encompassed by the present checklist (U.S.C. & G. 1250) extends from the ocean shores of Upper and Lower Matecumbe Keys to the 100 fathom curve about nine nautical miles beyond the reef. Collections as far as the next reefs to the northeast and southwest of Alligator Reef have been included. These adjacent reefs are Crocker Reef, six nautical miles northeast and Tennessee Reef, 10 miles southeast of Alligator Reef.

Shore habitats in the study area consist mainly of beaches of mixed coral and shell rubble, calcareous sand, and finer material. The beach slope is gentle so that a distance of about one nautical mile from shore is reached before a depth of six meters is encountered. A few shore areas consist of eroded coral rock and in one location, Indian Key, the rocky shore is undercut with a water depth of one meter at shore.

The lagoon or Hawk Channel extends for a distance of about 2.5 nautical miles from shore and the bottom consists of large beds of Thalassia alternating with areas of flat rocky bottom dominated by alcyonarians, sponges, and Sargassum. Large groups of patch reefs occur in several locations in the lagoon and isolated coral heads in many areas.

The sandy back-reef begins about one mile inside the outer-reef tract. The substrate consists largely of sandy bottom mixed with increasing amounts of rubble toward the reef and with finer sediments nearer the lagoon. Many isolated patches of Thalassia dot the back-reef and a number of rocky patches covered with alcyonarians and sponges are also found.

The reef-top consists largely of eroded coral rock and rubble interspersed with small patches of sand. An eroded rocky ledge up to 2.5 meters high extends for several hundred meters along the reef-top at Alligator Reef and is an important concentration point for many species of fishes. Numerous corals and alcyonarians occur in the rocky areas but coral growth on the reef-top at Alligator Reef is not as luxuriant as at certain other reefs on either side of it along the Florida reef tract. Coral development, however, has little direct effect on the fish fauna as coral is important chiefly as shelter. Because of the shelter afforded by the rocky ledge and the presence of extensive and diverse back-reef forage areas Alligator Reef actually has a greater concentration of reef fishes than many other locations with more luxuriant coral growth. Depths on the reef-top at Alligator Reef vary from 1.5 to six meters with four to five meters over the ledge.

Seaward of the reef-top the bottom slopes over a distance of 150 to 200 meters to a depth of 22 to 24 meters and then drops more or less abruptly to a depth of 29 meters (16 fathoms). The deep-reef makes up the outer edge of this zone. It consists of heavily eroded coral rock overgrown by profuse growths of live corals, alcyonarians, and sponges. The outer face is steep and falls off onto silty sand and sandy rubble bottom at a depth of 28 to 29 meters. The deep-reef is separated from the reef-top in most areas by a band of sand 100 meters or more wide in depths of 10 to 20 meters.

Beyond the deep-reef the bottom shelves gently so that it is necessary to go about one mile beyond the outer edge of the deep-reef before a depth of 45 meters is reached and nine miles before a depth of 180 meters (100 fathoms) is reached. The bottom over most of this area consists of various mixtures of calcareous silt, sand, and rubble.

Small rocky outcrops at a depth of 45 meters occur in one location and are a focal point for concentrations of a number of deep water reef species. Other areas of low relief are found in deeper water and an extensive zone of very rugged relief occupies the outer edge of the study area in depths of 145 to 180 meters.

For the purposes of the present paper the reef community is defined as that occupying the reef-top itself and all of the reef associated habitats from the shoreward edge of the lagoon to a depth of 45 meters, about one mile beyond the outer edge of the deep-reef.

#### WORK AT ALLIGATOR REEF

The only reference to biological work at Alligator Reef prior to the present program is a paper by Breder (1927). His report on the fishes collected by the first oceanographic expedition of the "Pawnee" in 1925 includes about 15 species of reef fishes collected at Alligator Reef.

The present work at Alligator Reef was begun by the author in 1958 and has continued for varying periods during each year of the subsequent nine years. Use of rotenone-based fish toxicants and SCUBA equipment has been the single most productive collecting technique. Well over 200 such collections have been made in all major habitats from shore to 45 meters. Hundreds of additional collections have also been made by more selective methods. Spears, traps, handnets, castnets, trawls, angling, and other techniques have been used extensively. In depths greater than 45 meters bottom collections have been made by trawl and hook and line only, and even these techniques have not been used exhaustively though perhaps 50 days of hook and line fishing at these depths have been carried out.

In addition to collecting, several hundred days have been spent in observing with skin and SCUBA diving equipment. Over 100 night diving trips have also been made for observations and limited collecting.

#### PUBLICATIONS

Virtually all fishes collected at Alligator Reef have been deposited in the Ichthyological museum of the Institute of Marine Science of the University of Miami. This material has been used by a number of investigators and a total of 34 publications and three studies in press now deal with fishes from Alligator Reef.

Anderson, Gehringer, and Berry (1966), Böhlke (1967a, 1967b), Böhlke and Robins (1960a, 1960b, 1962), Böhlke and Springer (1961), Böhlke and Thomas (1961), Courtenay (1961, 1967), Davls (1966), Eschmeyer (1965), Gilbert (1967), Hubbs (1963), Randall (1963b, 1965a, 1966), Randall and Böhlke (1965), Robins and Starck (1961), Robins and Tabb (1965), Springer (1962), and Starck and Courtenay (1962), treat material from Alligator Reef in systematic studies. These papers include 12 new Florida records and descriptions of ten new species from Alligator Reef.

Clardell (in press), Feddern (1963, 1965, in press), Gould (1965), McKenny (1959), Randall and Randall (1960), Randall (1962), Schroeder and Starck (1964), Starck (1960), Starck and Schroeder (1965), Starck (in press), Starck and Davls (1967), and Myrberg, Brahy, and Emery (1967) deal with biological aspects of fishes from Alligator Reef and include one new record of occurrence for Florida.

Numerous black and white and color photographs of reef fishes and reef habitats at Alligator Reef may also be found in Starck and Brundza (1966).

#### ACKNOWLEDGMENTS

From 1958 to 1960 collections at Alligator Reef were made by the author in co-operation with a study of the inshore fish fauna of the Florida Keys headed by C. Richard Robins under National Science Foundation grants-in-aid 3881 and 9695. Field work in the summer of 1964 was connected with investigations of the feeding habits and related morphology of selected reef fishes supported by NSF-GB-1456 of which Dr. Robins was principal investigator.

Since June 1965 work at Alligator Reef has been supported by NSF-GB-3628 of which the author is principal investigator.

The National Geographic Society has also contributed considerable support to various facets of the work since 1962.

Over the years, many individuals have participated in field work at Alligator Reef. Henry A. Feddern, Richard H. Chesher, Alan R. Emery and William P. Davis have been especially helpful and are, themselves, carrying out studies on the biology of various reef organisms. Robert E. Schroeder has also assisted in field operations at various times.

John E. Randall was involved in early collecting efforts and has been most co-operative in subsequent years with his ideas, observations, and data on reef fish biology.

C. Richard Robins has made available all possible facilities of the ichthyological museum of the Institute of Marine Science and has given invaluable aid in taxonomic problems concerning reef fishes. He has also critically reviewed this manuscript.

James E. Böhlke furnished a complete list of the known fish fauna of the Bahama Islands and solved several perplexing taxonomic problems.

Jo D. Starck, the author's wife, assisted in all phases of the work from field operations and processing of collections and data to completion of the manuscript.

#### DISCUSSION

Alligator Reef now has what is probably the most thoroughly known fish fauna of any single coral reef. The 517 species included in the present list also considerably exceeds the 440 odd fishes recorded by Longley and Hildebrand (1941) from the Tortugas; previously the richest known shore fish fauna of any single locality in the New World. This fact is indicative only of the richness of coral reef faunas in general rather than that of Alligator Reef in particular. With thorough collecting many other reefs in the West Indian Region will undoubtedly be found to have equal or even greater fish faunas.

Of the 517 species recorded some 389 are actually members of the reef community and are normally found in the area from the shore to a depth of 45 meters. The remaining species are either offshore pelagic forms, demersal species from deeper water, or stragglers from adjacent inshore areas.

In the checklist reef species have been divided into two groups to give some idea of the composition of the reef community. Primary reef species (indicated in the list by an asterisk) are those characteristically associated with coral reefs (253 species here). Secondary reef species are forms (indicated by +) which, though normal residents of Alligator Reef and other reefs, are equally or even more characteristic of areas not associated with

reefs (136 species here). The latter includes a number of occupants of sandy bottom and grass habitats as well as wide ranging species such as sharks.

In recent years a considerable number of publications have expanded our knowledge of West Indian reef fishes. Systematic notes, descriptions of new species, and generic and familial revisions have clarified many problems. Thirty-six of the reef species in the present list have been described in the past 11 years (since 1955) and all but one of the eight known new species included here are now in the process of being described by various workers. To assist the non-systematist amid this welter of new names and changes in old ones common names follow the scientific ones. When common names were unavailable they were coined; otherwise the common names of Bailey *et al.* (1960) were generally followed. In some cases the names recommended by Bailey *et al.* were apparently taken from those listed by earlier scientific workers and are not coincident with names standardly used by aquarists, skindivers, and fishermen. In these cases the commonly used name is followed rather than the recommended one. In a few additional cases where descriptive names suggested by Bailey *et al.* were misleading for the live fish a new name is given. Wherever such changes have been made the reasons are given.

In addition to Bailey *et al.* who listed fishes of the United States and Canada Briggs (1958) also dealt comprehensively with Florida fishes in his list of Florida fishes. Both papers, though important and useful works, contribute to zoogeographic confusion by including species which were not previously recorded from Florida. Unfortunately these species were not differentiated from ones based on published record.

In a number of cases in Briggs' work and in a lesser number in Bailey *et al.*, species were anticipated on the basis of a pattern of known distribution which would probably include Florida though no specimens had been collected there. Some of these speculations have been vindicated by subsequent collections. Others have not.

Both publications also included species which had been collected but not recorded though no indication of this status is given. In the case of Bailey *et al.* a number of these were based on material collected at Alligator Reef by the author and curated by Dr. C. Richard Robins, a co-author of that work. Therefore, 16 of the species from the present list are included by Bailey *et al.* but are not previously recorded.

Whenever possible species binomials used are those recommended by recent studies. For convenience the familial order used by Bailey *et al.* has been followed and species within a family listed alphabetically. Non-reef species are designated as offshore for those pelagic species which occur from the reef-top seaward and the demersal species which live in depths greater than 45 meters. Inshore species are those which normally live in Florida Bay and stray into the reef area (for a more detailed list of Florida Bay fishes see Tabb and Manning, 1961).

To indicate the abundance of each species five qualitative categories are used. Rare species are those of which three or fewer specimens have been seen or collected among a number of collections in their habitat. Occasional ones are species collected or observed at irregular intervals. Species listed as frequent have been seen or collected on numerous occasions or are taken in a large percentage of collections from their habitat. Common species are ones that may be found during virtually every dive or collection in the proper area. Abundant indicates a common species present in large numbers.

Though the South Florida area is often thought of as subtropical it is

Important to emphasize that the marine fauna and flora of the Florida Keys is wholly tropical in nature as pointed out by Stephenson and Stephenson (1958: 393). While the Florida Keys do lie just outside of the Tropic of Cancer the Florida Current displaces tropical marine conditions northward. On rare occasions exceptionally cold weather may drop water temperatures near shore to the lower lethal limit for some organisms but the reef area from the lagoon seaward is unaffected by these short cold spells. Faunal differences between the Florida reefs and Bahamian ones, for example, are evidently connected with other factors than temperature. The unusually heavily sedimented nature (for a coral reef) of much of the sea floor in the Keys is perhaps the single most important factor.

Although ecological conditions at Alligator Reef restrict certain species many others are favored. Especially abundant and noticeable are the grunts (*Pomadouridae*), snappers (*Lutjanidae*), and sea basses (*Serranidae*), and the general underwater appearance of the reef fish population density is not equalled on most other West Indian reefs.

The fishes of Alligator Reef are typical of West Indian reefs in general and constitute a fauna that can hardly be considered impoverished in reef forms. With adequate collecting many of the faunal differences between various locations in this faunal region are disappearing and those that remain are beginning to fit a pattern.

Briggs (1958: 235) listed as Florida endemics 26 nominal species that are included in or are synonyms of reef species in the present list. At the present time only one of these (*Hypoplectrus gemma*) is still known only from Florida. To this may be added two subsequently described species (*Lythrypnus phorellus* and *Ophidion selenops*), one undescribed species (*Chromis* sp.), a species previously recorded erroneously from the West Indies (*Elacatinus oceanops*), and two species which range outside Florida along the continental coast (*Litopropoma eukrines* and *Equetus umbrosus*), for a total of seven out of 389 reef inhabitants that are not recorded elsewhere in the West Indies. With further collecting it is probably that several of these seven will also be found outside Florida. Except for *Ophidion* all other Western Atlantic species of the genera involved are West Indian reef forms and even *Ophidion* has several West Indian reef representatives.

Of the seven species found, so far, only in U.S. waters, two are small gobies, two are small serranids, one a dwarf cusk eel, and one a pomacentrid. The tendency for zoogeographic differentiation within the region to be restricted to small species with limited ability to travel and little or no pelagic larval period is apparent. Rosenblatt (1963: 176) has pointed out these and additional factors which have contributed to rapid evolution in such fishes. It is also evident that most species of even these groups are not restricted to Florida and the barrier has been effective for only a relatively limited number of forms.

Differences in faunal composition between reefs in the West Indies can therefore be regarded primarily as ecological or quantitative rather than zoogeographic or qualitative. With a much larger species complement available to a reef than actually lives there the faunal composition of a given reef is a function of what can live there rather than what can get there. Though two reefs may reveal similar species lists with extensive collecting, the populations of each species are often quite dissimilar depending upon differences in geography, hydrography, and biology of the reefs.

Comparison of the fish fauna of Alligator Reef with other areas on an equitable basis is difficult because of lack of adequate collections elsewhere. Longley and Hildebrand (1941) report a total of 442 nominal species from the

Tortugas of which about 300 may be considered reef inhabitants. The species taken at Alligator but not at Tortugas largely reflect differences in techniques used. The groups showing the greatest difference are the burrowing eels and cusk eels, the small cryptic gobies, and the deeper water labrids.

In view of the nature of the differences in recorded species and collecting techniques no significant faunal differentiation between the Tortugas and Alligator Reef can be postulated and it is probable none exists.

Over recent years extensive collecting with rotenone-based ichthyocides and SCUBA gear has greatly expanded our knowledge of the fishes of the Bahama Islands. The greatest part of recent ichthyological work in the Bahamas has been carried out by James E. Böhlke and Charles C. G. Chaplin of the Academy of Natural Sciences of Philadelphia. Dr. Böhlke kindly furnished the author with a list of fishes known from the Bahamas and it is on this basis that the following comparisons are made. In this case collecting techniques are comparable between the two areas and over 50 of the Bahamian collections were made by the author using identical techniques to the ones used at Alligator Reef. However, it must still be considered that we are comparing collections made in the many reef situations of a large group of islands with those made on one reef.

Dr. Böhlke's list of Bahamian fishes includes 496 species in total, of which about 450 may be found on coral reefs. Total fauna is, therefore, slightly less than that of Alligator Reef but the reef dwelling component is fifteen percent greater.

Only one family involved is not common to both areas. The serranoid family Grammidæ is not represented at Alligator Reef and is unrecorded from Florida. However, one species, Gramma loreto, is reportedly taken occasionally by aquarium fish collectors in the region from Fort Lauderdale to Palm Beach Florida. In that area the Florida current is closer to shore than at any other point along the Florida coast. This feature coupled with the absence of extensive adjacent estuarine or bay areas permits clear oceanic water to prevail over the outer reef areas there. As a result a number of other species of fishes and invertebrates characteristic of the West Indies but rare or absent elsewhere in Florida are found there. Among fishes these include, in addition to Gramma loreto, the pygmy angelfish (Centropyge argi) and the longsnout butterflyfish (Prognathodes aculeatus). This situation further illustrates that local conditions and not zoogeographic barriers are the causative agents behind much of the apparent faunal differentiation between separate reef areas in the West Indian region.

On the generic level 35 genera of reef fishes from the Bahamas have not been found at Alligator Reef but 18 of these have been taken elsewhere in Florida. Sixteen genera of reef fishes taken at Alligator Reef are unknown in the Bahamas but all have been taken elsewhere in the West Indian region.

Reef species occurring in the Bahamas but not collected at Alligator Reef total 126 but 46 of these have been taken elsewhere in Florida. Seventy-two reef species from Alligator Reef are unknown for the Bahamas; however, all but seven of these (see above) have been taken elsewhere in the West Indies. Four of these seven are normally found in depths greater than 15 meters at which depths relatively few rotenone collections, or none at all, have been made over most of the West Indian Region.

The 82 Bahamian reef species not known from Florida are scattered among 27 families but the greatest number of these (51%) occur in four families. These families, the Cichlidae (including the Tripterygiidae and Chaenopsidae), Gobiidae, Apogonidae, and Gobiessocidae are all composed of small species

with short or non-existent pelagic larval periods and which as adults do not range widely.

The nature of the fish fauna of Alligator Reef and of the Florida reefs in general can be summarized as follows:

During the last glacial period tropical marine species were restricted to a much narrower latitudinal area and the Florida shore fauna was predominantly temperate in nature (Walters and Robins, 1961: 16). The present reef fish fauna consists of relatively recent immigrants that have crossed the Florida Current from the West Indies or drifted with it from the Yucatan peninsula. This barrier has apparently been effective only for forms with very limited swimming powers as adults and with reduced or absent planktonic larval periods. This category includes the speciose gobies and blennies. Certain other forms while able to cross the Straits have been unable to develop normal populations due to local conditions.

Two factors are readily apparent which might adversely affect some West Indian reef species in Florida. One is an unusually high degree of siltation for a coral reef area and the other is a surprisingly dense population of many species on the Florida reefs perhaps creating an unfavorable competitive situation for some other species.

Among the species which occur at Alligator Reef but for which local conditions are apparently unfavorable are:

Myripristis jacobus, Plectrypops retrospinis, Cephalopholis fulva, Liopropoma mowbrayi, Liopropoma rubre, Mycteroperca tigris, Inermia vittata, Lutjanus mahogani, Centropyge argi, Prognathodes aculeatus, Ballistes vetula, and Cantherhines macrocerus.

In contrast to the faunal limitations imposed by the barrier of the Florida Current and by local conditions, other factors have operated to permit a surprisingly rich reef fish fauna in Florida. The Florida Current maintains favorable temperatures over the reefs and brings an abundant supply of planktonic food. Adjacent and extensive inshore regions of high productivity furnish excellent forage areas for adults of a number of species and nursery grounds for juveniles of many. Finally a wide range of reef and reef-associated habitats are found.

The net results of these factors are that the fish fauna consists of West Indian species with the exception of seven out of nearly 400 reef species and some of these seven will probably also be found in the West Indies with further collecting. Results of the favorable factors are such that not only are a large number of species found in a single area but populations of many are unusually dense.

Outside the Western Atlantic the best known reef fish fauna is that of Hawaii. In comparison, however, it must be remembered that in Hawaii we are considering the fauna of an archipelago 1,500 miles long and not that of a single reef. Gosline and Brock (1960) report from Hawaii a total of 448 inshore species from depths less than 100 fathoms. Of these just under 400 species can be considered reef dwellers. The very similar number of reef species between Alligator Reef and the entire Hawaiian chain including Johnston Island is indicative of the surprising richness of the Florida reef fauna.

Other than at Hawaii, which is impoverished in comparison, the rich Indo-Pacific fauna is very poorly studied. Two areas have received more recent and extensive treatment than the rest. Schultz et al. (1951, 1960, and 1966) report about 625 reef species from the Marshall and Marianas Islands. The limited nature of the collections on which their work was based indicate an

actual fauna of at least 800 reef dwelling fishes.

Smith and Smith (1963) report approximately 740 reef species from the Seychelles. From personal observation and collecting there I would feel safe in estimating a total reef fish fauna of over 900 species.

While these figures are totals for relatively large island groups it appears probably that the fauna of tropical Indo-Pacific reefs is approximately twice as speciose as that of West Indian reefs.

In comparing the general systematic composition of the Alligator Reef fauna or the West Indian fauna in general with that of the tropical Indo-Pacific area the most noticeable differences are the greater importance of the Clariidae and Pomadasylidae in the West Indian Region and the increased significance of the Blenniidae and Acanthuridae in the Indo-Pacific. A few specialized Indo-West Pacific families are not represented at all in the West Indian Region.

A significant portion of the Clariidae, the Chaenopsidae, has been recognized as a separate family (Stephens, 1963) and together with the Dactyloscopidae are the only families of West Indian reef fishes which are known only from the New World. The remaining families are all represented in the Indo-Pacific.

The Blenniidae of the Indo-Pacific fill, to some extent, niches occupied by the Clariidae of the West Indian Region.

The Pomadasylidae are represented in the Indo-Pacific by the closely related Gateriidae which are also ecologically similar and the two groups probably do not rate familial separation.

The wide range of niches defined by the many species of Indo-Pacific Acanthurids are apparently exploited only by the four Western Atlantic species of *Acanthurus*.

Other characteristic and speciose reef fish families of the Indo-Pacific such as the Muraenidae, Ophichthidae, Holocentridae, Serranidae, Lutjanidae, Apogonidae, Carangidae, Mullidae, Chaetodontidae, Pomacentridae, Labridae, Scaridae, Gobiidae, Scorpaenidae, Blenniidae, Balistidae, Ostraciidae and Diodontidae are all well represented at Alligator Reef. With the exception of the Mullidae (two species) and the Ostraciidae (four species) all these families have five or more species at Alligator Reef.

## SUMMARY

The fish fauna of Alligator Reef is fully tropical West Indian in nature and surprisingly rich. The known fauna from this Reef and immediate environs now includes a greater number of species than has been previously recorded from any one location in the New World. The reef fish fauna probably consists of post-glacial immigrants and accordingly the most noticeable differentiation from the fauna of the West Indian Islands includes the absence of certain smaller demersal species with limited swimming power as adults and little or no pelagic larval period.

In comparison with the tropical Indo-Pacific reef fish fauna that of Alligator Reef is similar in composition on the familial and generic level. The total number of species involved is very close to that of the Hawaiian reef fish fauna but only about one-half that of the Marshall and Marianas Islands or the Seychelles.

## A LIST OF FISHES OF ALLIGATOR REEF, FLORIDA

The reef habitat, primary and secondary reef species, and categories of abundance have been defined above. Comments on scientific and common names used are also made above.

Where species binomials differ from those previously used reasons are given as they are when common names differ from those suggested by Bailey et al. (1960). While stability in common names is certainly desirable the author is of the opinion that for ichthyologists to insist upon a common name in the face of uniform popular usage of another equally appropriate name contributes nothing to nomenclatural stability. In other cases a suggested common name may be misleading and require change. One example is the previously recommended whiteline goby which in life has a bright yellow line. Persons who use common names will probably never see a faded preserved specimen with a white line. Unfortunately, therefore, it appears that recommended common names like scientific ones may sometimes have to be changed. Such name changes, if reasonable and conservative in nature, should in the long run contribute to stability rather than detract from it.

Species of which specimens from Alligator Reef are in the Ichthyological Museum of the Institute of Marine Science are identified by the letters UMML. The four species based on sight records only are so stated.

All new records of occurrence for Florida are identified as such and in a few cases where taxonomic status is uncertain this is also noted.

#### LAMNIDAE - MACKEREL SHARKS

Isurus oxyrinchus Rafinesque, MAKO, rare, offshore, one specimen examined but not preserved.

#### ORECTOLOBIDAE - NURSE SHARKS

+Ginglymostoma cirratum (Bonnaterre), NURSE SHARK, frequent, UMML.

#### RHINCODONTIDAE - WHALE SHARKS

Rhincodon typus Smith, WHALE SHARK, rare, one specimen seen by the author near Duck Key about 17 miles west of Alligator Reef.

#### CARCHARHINIDAE - REQUIEM SHARKS

- Carcharhinus falciformis (Valenciennes), SILKY SHARK, common, offshore.
- +Carcharhinus leucas (Valenciennes), BULL SHARK, frequent to common.
- Carcharhinus limbatus (Valenciennes), BLACKTIP SHARK, occasional, inshore.
- Carcharhinus obscurus (Lesueur), DUSKY SHARK, frequent, offshore.
- +Galeocerdo cuvieri (Peron and Lesueur), TIGER SHARK, occasional to frequent.
- +Negaprion brevirostris (Poey), LEMON SHARK, common to abundant inshore, occasional reef, UMML.
- Prionace glauca (Linnaeus), BLUE SHARK, rare, one specimen caught around 1940 about 10 miles SW of Alligator Reef, identified by the late Albert Pflueger, Miami taxidermist.

#### SPHYRNIIDAE - HAMMERHEAD SHARKS

- +Sphyrna mokarran (Rüppell), GREAT HAMMERHEAD, occasional to frequent.
- +Sphyrna tiburo (Linnaeus), BONNETHEAD, occasional to frequent.
- Sphyrna zygaena (Linnaeus), SMOOTH HAMMERHEAD, occasional, offshore, UMML.

#### PRISTIDAE - SAWFISHES

Pristis pectinatus Latham, SMALL TOOTH SAWFISH, occasional, inshore, UMML.

#### RHINOBATIDAE - GUITARFISHES

Rhinobatos lentiginosus (Garman), ATLANTIC GUITARFISH, rare, inshore.

## TORPEDINIDAE - ELECTRIC RAYS

- +Narcine brasiliensis (Olfers), LESSER ELECTRIC RAY, frequent, UMML.

## RAJIDAE - SKATES

- Raja garmani Whitley, ROSETTE SKATE, common, offshore, UMML.

## DASYATIDAE - STINGRAYS

- +Dasyatis americana Hildebrand and Schroeder, SOUTHERN STINGRAY, frequent reef, common inshore.  
 +Urolophus harrisi (Cuvier), YELLOW STINGRAY, common, UMML.

## MYLIOBATIDAE - EAGLE RAYS

- +Aetobatus narinari (Euphrasen), SPOTTED EAGLE RAY, frequent.

## MOBULIDAE - MANTAS

- Manta birostris (Walbaum), ATLANTIC MANTA, occasional, offshore.

## ELOPIDAE - TARPONS

- Elops saurus Linnaeus, LADYFISH, frequent, inshore.  
Megalops atlantica Valenciennes, TARPON, common, inshore, UMML.

## ALBULIDAE - BONEFISHES

- Albula vulpes (Linnaeus), BONEFISH, common, inshore.

## CLUPEIDAE - HERRINGS

- +Harengula humeralis Cuvier, REDEAR SARDINE, common, UMML.  
 +Harengula pensacolae Goode and Bean, SCALED SARDINE, common, UMML.  
 +Jenkinsia lamprotaenia (Gosse), DWARF HERRING, common, UMML.  
 \*Jenkinsia majua Whitehead, LITTLE-EYE DWARF HERRING, common, UMML.  
 First record for Florida.

William N. Eschmeyer who is presently studying the species of Jenkinsia and who identified the material from Alligator Reef informed the author that several species may be involved in what is now known as Jenkinsia majua. The identification of Alligator Reef material under this name is, therefore, provisional.

- +Jenkinsia stollferi Jordan and Gilbert, NARROWSTRIPE DWARF HERRING, frequent, UMML.

- Oplithonema oglinum (Lesueur), THREAD HERRING, frequent, inshore.

- +Sardinella anchovia (Valenciennes), SPANISH SARDINE, frequent, UMML.

Hildebrand (1963) recognizes three species of Sardinella from the Western Atlantic; pinnula known only from Bermuda, anchovia ranging from Woods Hole to Florida and probably to Brazil, and brasiliensis which occurs from Florida to southern Brazil. Specimens from Alligator Reef fit descriptions of all three species with the smallest specimens generally corresponding best with brasiliensis, medium sized ones with anchovia and the largest specimens with pinnula. More than one type frequently occurs in the same school and it appears probable that only one biological species is involved. Only the oldest name, anchovia, is therefore recognized here. This name has previously been used extensively for the Florida species.

## ENGRAULIDAE - ANCHOVIES

- Anchoa mitchilli (Evermann and Marsh), DUSKY ANCHOVY, common, inshore, UMML.

Anchoa mitchilli (Valenciennes), BAY ANCHOVY, common, Inshore, UMML.

#### SYNODONTIDAE - LIZARDFISHES

+Saurida normani Longley, SHORTJAW LIZARDFISH, frequent to common, reef and offshore, UMML.

Synodus foetens (Linnaeus), INSHORE LIZARDFISH, frequent, UMML.

+Synodus intermedius (Spix), SAND DIVER, occasional reef, common offshore, UMML.

+Synodus poeyi Jordan, OFFSHORE LIZARDFISH, occasional reef, common offshore, UMML.

\*Synodus synodus (Linnaeus), RED LIZARDFISH, common, UMML.

+Trachinocephalus myops (Forster), SNAKEFISH, frequent, reef and offshore, UMML.

#### ARGENTINIDAE - ARGENTINES

Glossanodon pygmaeus Cohen, PYGMY ARGENTINE, rare, offshore, UMML.

#### ARIIDAE - SEA CATFISHES

Galeichthys felis (Linnaeus), SEA CATFISH, occasional, Inshore.

#### XENOCONGRIDAE - PENCIL EELS

+Chlorrhinus suensoni Lütken, STUBBY PENCIL EEL, rare, UMML. First record for Florida.

\*Kaupichthys atlanticus Böhlke, GRAY PENCIL EEL, occasional, UMML. First record for Florida.

#### CONGRIDAE - CONGER EELS

+Ariosoma impressa (Poey), BANDTOOTH CONGER, rare, UMML.

\*Conger triporiceps Kanazana, MANYTOOTH CONGER, rare, UMML.

\*Nystacichthys halli (Böhlke), GARDEN EEL, frequent, UMML. First record for Florida.

+Paraconger caudilimbatus (Poey), MARGINTAIL CONGER, rare, UMML.

#### MORINGUIDAE - SPAGHETTI EELS

\*Moringua edwardsi (Jordan and Bollman), SPAGHETTI EEL, frequent, UMML. First record for Florida.

Only one species of this family is presently recognized in the West Indian Region but some workers believe that further investigation may reveal more than one species is involved. The present species identification is therefore tentative.

#### OPHICHTHIDAE - SNAKE EELS

+Ahila egmontis (Jordan), KEY WORM EEL, occasional, UMML.

\*Aprognathodon platyventris Böhlke, BANDED SNAKE EEL, occasional, UMML.

+Bascanichthys scuticaris (Goode and Bean), WHIP EEL, rare, UMML.

\*Carolophia toxochila Böhlke, FLANGED SNAKE EEL, rare, UMML. First record for Florida.

+Echlopsis mordax (Poey), SNAPPER EEL, rare, UMML.

\*Myrichthys acuminatus (Gronow), SHARPTAIL EEL, rare, UMML.

+Myrichthys ocellatus (Kaup), GOLDSPOTTED EEL, occasional, UMML.

Included by Bailey et al. (1960), but not previously recorded from U.S. waters.

+Myrophis punctatus Lütken, SPECKLED WORM EEL, occasional, UMML.

+Sphagebranchus ophioneus (Evermann and Marsh), SURF EEL, frequent, UMML. Böhlike (MS) has synonymized S. conklini with S. ophioneus, leaving only one recognized species in the West Indian Region.

+Verma sp., AUGERNOSE WORM EEL, frequent, UMML.

+Verma sp., BLUNTNOSE WORM EEL, frequent, UMML.

Due to the present state of systematic knowledge of this genus it is not possible to give positive identifications. At least one species is new according to Dr. James E. Böhlike who is studying this material for a future report.

#### MURAENIDAE - MORAYS

\*Echidna catenata (Bloch), CHAIN MORAY, rare, UMML.

\*Enchelycore nigricans (Bonnaterre), VIPER MORAY, common, UMML.

Included by Bailey et al. (1960) but not previously recorded from U.S. waters.

\*Enchelycore sp., DWARF VIPER MORAY, common, UMML. An undescribed species of moray closely related to E. nigricans but smaller. What appears to be the same species occurs in the Bahamas and the Antilles.

\*Gymnothorax funebris Ranzani, GREEN MORAY, frequent to common, UMML.

\*Gymnothorax moringa (Cuvier), SPOTTED MORAY, common, UMML.

+Gymnothorax nigromarginatus (Girard), BLACKEDGE MORAY, rare, UMML.

\*Gymnothorax vicinus (Castelnau), PURPLEMOUTH MORAY, common, UMML.

\*Muraena millaris (Kaup), GOLDENTAIL MORAY, frequent, UMML.

Included by Bailey et al. (1960), but not previously recorded from U.S. waters.

\*Uropterygius diopus Böhlike, FINLESS MORAY, occasional, UMML.

#### BELONIDAE - NEEDLEFISHES

Ablennes hians (Valenciennes), FLAT NEEDLEFISH, occasional, offshore, UMML.

+Platybelone argalus (Lesueur), KEELED NEEDLEFISH, common, UMML.

Strongylura marina (Walbaum), ATLANTIC NEEDLEFISH, common, inshore.

Strongylura notata (Poey), REDFIN NEEDLEFISH, common, inshore, UMML.

Tylosurus acus (Lacépède), AGUJON, occasional, offshore, UMML.

+Tylosurus crocodilus (Peron and Lesueur), HOUNDFISH, common, UMML.

#### HEMIRAMPHIDAE - HALFBEAKS

Chriodorus atherinoides Goode and Bean, HARDHEAD HALFBEAK, occasional, inshore, UMML.

Euleptorhamphus velox Poey, FLYING HALFBEAK, occasional, offshore, UMML.

Hemiramphus balao Lesueur, BALAO, frequent, offshore, UMML.

+Hemiramphus brasiliensis (Linnaeus), BALLYHOO, common, reef and off-shore, UMML.

Hyporhamphus unifasciatus (Ranzani), HALFBEAK, frequent, offshore (Juvenile), and inshore (Adult), UMML.

#### EXOCOETIDAE - FLYINGFISHES

Cypselurus exsiliens (Linnaeus), BANDWING FLYINGFISH, offshore, UMML.

Observations and collections of most species of flyingfishes are insufficient to permit any realistic attempt at classification as to "occasional", "frequent", etc.

Cypselurus furcatus (Mitchill), SPOTFIN FLYINGFISH, offshore, UMML.

Cypselurus heterurus (Rafinesque), ATLANTIC FLYINGFISH, common, offshore, UMML.

Exocoetus obtusirostris Günther, OCEANIC TWO-WING FLYINGFISH, offshore, UMML.

Hirundichthys affinis (Günther), FOURWING FLYINGFISH, offshore, UMML.

Hirundichthys rondeletii (Valenciennes), BLACKWING FLYINGFISH, offshore, UMML.

Parexocoetus brachypterus (Richardson), SAILFIN FLYINGFISH, common, offshore, UMML.

Prognichthys glabifrons (Valenciennes), BLUNTNOSE FLYINGFISH, common, offshore, UMML.

#### CYPRINODONTIDAE - KILLIFISHES

Floridichthys carpio (Günther), GOLDSPOTTED KILLIFISH, common, Inshore, UMML.

Fundulus confluentus Goode and Bean, MARSH KILLIFISH, common, Inshore, UMML.

Fundulus similis (Baird and Girard), LONGNOSE KILLIFISH, common, Inshore, UMML.

#### POECILIIDAE - LIVEBEARERS

Gambusia affinis (Baird and Girard), MOSQUITOFISH, common, Inshore, UMML.

Poecilia latipinna (Lesueur), SAILFIN MOLLY, common, Inshore, UMML.

#### AULOSTOMIDAE - TRUMPETFISHES

\*Aulostomus maculatus Valenciennes, TRUMPETFISH, frequent, UMML.

#### FISTULARIIDAE - CORNETFISHES

\*Fistularia tabacaria Linnaeus, CORNETFISH, frequent, UMML.

#### CENTRISCIDAE - SNIPEFISHES

Macrorhamphosus gracilis (Lowe), SLENDER SNIPEFISH, rare, offshore, UMML.

#### SYNGNATHIDAE - PIPEFISHES AND SEAHORSES

+Corythoichthys albirostris Heckel, WHITENOSE PIPEFISH, rare, UMML.

Corythoichthys brachycephalus (Poey), CRESTED PIPEFISH, common, Inshore, UMML.

+Hippocampus erectus Perry, RIBBED SEAHORSE, frequent, UMML. This common name has been changed from that of Bailey *et al.* (1960) to avoid confusion with the following species.

+Hippocampus reidi Ginsburg, SPOTTED SEAHORSE, rare, UMML. First record for Florida.

Hippocampus zosterae Jordan and Gilbert, DWARF SEAHORSE, frequent, Inshore.

+Micrognathus crinitus (Bean and Dresel), FRINGED PIPEFISH, frequent, UMML.

+Micrognathus crinitus (Jenyns), INSULAR PIPEFISH, frequent, UMML.

+Micrognathus vittatus (Kaup), (both *ensenadae* and *vittatus* color patterns) BANDED PIPEFISH, occasional, UMML. Due to differences in ecology, and behavior, the author is of the opinion that the two forms are probably separate species.

+Syngnathus elucens Poey, SHORTFIN PIPEFISH, rare, UMML.

- +Syngnathus louisianae Günther, CHAIN PIPEFISH, rare, UMML.  
Syngnathus peiagicus Linnaeus, SARGASSUM PIPEFISH, rare, offshore, UMML.  
 +Syngnathus springeri Herald, BULL PIPEFISH, rare, UMML.

#### HOLOCENTRIDAE - SQUIRRELFISHES

- \*Adloryx bullisi (Woods), DEEPWATER SQUIRRELFISH, frequent, UMML.  
 \*Adloryx coruscus (Poey), REEF SQUIRRELFISH, frequent, UMML.  
 \*Adloryx vexillarius (Poey), DUSKY SQUIRRELFISH, common, UMML.  
 \*Holocentrus ascensionis (Osbeck), SQUIRRELFISH, common, UMML.  
 \*Holocentrus rufus (Walbaum), LONGSPINE SQUIRRELFISH, frequent, UMML.  
 \*Myripristis jacobus Cuvier, SOLDIERFISH, occasional to frequent, UMML.  
 \*Plectropops retropinnis (Guichenot), CARDINAL SOLDIERFISH, one slight record only. Bailey et al. (1960) include it, but there is no previous record from U.S. waters published or unpublished.

#### CAPROIDAE - BOARFISHES

- Antigonia capros Lowe, DEEPBODY BOARFISH, rare, offshore, UMML.

#### CENTROPOMIDAE - SNOOKS

- +Centropomus undecimalis (Bloch), SNOOK, common, UMML.

#### SERRANIDAE - SEA BASSES

- \*Alphestes afer (Bloch), MUTTON HAMLET, rare, UMML.  
Anthias sp., (unidentified), rare, offshore, UMML.  
 \*Cephalopholis fulva (Linnaeus), CONEY, occasional, UMML.  
 \*Dermatolepis inermis (Valenciennes), MARBLED GROUPER, rare, UMML.  
 +Diplacrum bivittatum (Valenciennes), DWARF SAND PERCH, common, UMML.  
 +Diplacrum formosum (Linnaeus), SAND PERCH, frequent, UMML.  
 \*Epinephelus adscensionis (Osbeck), ROCK HIND, common, UMML.  
Epinephelus drummondhayi Goode and Bean, SPECKLED HIND, common, offshore, UMML.  
Epinephelus flavolimbatus Poey, YELLOWEDGE GROUPER, common, offshore.  
 \*Epinephelus guttatus (Linnaeus), RED HIND, common, UMML.  
 +Epinephelus itajara (Lichtenstein), JEWFISH, frequent, UMML.  
 +Epinephelus morio (Valenciennes), RED GROUPER, common, UMML.  
Epinephelus mystacinus (Poey), MISTY GROUPER, rare, offshore, UMML.  
Epinephelus nigritus (Holbrook), WARSAW GROUPER, common, offshore, UMML.  
Epinephelus niveatus (Valenciennes), SNOWY GROUPER, common, offshore, UMML.  
 \*Epinephelus striatus (Bloch), NASSAU GROUPER, common, UMML.  
 \*Hypoplectrus gemma Goode and Bean, BLUE HAMLET, common, UMML.  
 (Figure 1)  
 \*Hypoplectrus guttavarus (Poey), FOUREYE HAMLET, occasional, UMML.  
 (Figure 2) Not previously recorded from Florida.  
 \*Hypoplectrus nigricans (Poey), BLACK HAMLET, occasional, UMML.  
 (Figure 3) Not previously recorded from Florida.  
 \*Hypoplectrus puella (Cuvier), BANDED HAMLET, occasional, UMML.  
 (Figure 4)  
 \*Hypoplectrus unicolor (Walbaum), BUTTER HAMLET, common, UMML.  
 (Figure 5) In recent years most workers have relegated the many nominal species of Hypoplectrus to the synonymy of H. unicolor as a single highly variable species. Randall, Böhlke, and the author believe, on the

- basils of ecology, zoogeography, and some morphometric and meristic evidence that a number of valid species are involved. The five distinct forms found at Alligator Reef have therefore been recognized as species under the earliest name clearly based on each form. Only H. gemma is, on the basis of present evidence, restricted to Florida where it is quite common.
- \*L. lopropoma euklines (Starck and Courtenay), WRASSE BASS, frequent, UMML. Placement in the genus L. lopropoma is based on the recent capture of a specimen of L. aberrans which proved to be inseparable generically from Chorististium. This situation will be reported upon in detail by C. Richard Robins who brought this to the author's attention. For further explanation of generic relationships in this group of serranids see Starck and Courtenay (1962: 164-165).
- \*L. lopropoma mowbrayi Woods and Kanazawa, CAVE BASS, one specimen seen but not collected. Not previously recorded from Florida.
- \*L. lopropoma rubre Poey, PEPPERMINT BASS, occasional, UMML.
- \*Mycteroperca bonaci (Poey), BLACK GROUPER, common, UMML.
- \*Mycteroperca interstitialis (Poey), SALMON GROUPER, common, UMML.
- \*Mycteroperca microlepis (Goode and Bean), GAG, common, UMML.
- \*Mycteroperca phenax Jordan and Swain, SCAMP, common, UMML.
- \*Mycteroperca tigris (Valenciennes), TIGER GROUPER, rare, sight record only.
- \*Mycteroperca venenosa (Linnaeus), YELLOWFIN GROUPER, occasional, UMML.
- \*Paranthias furcifer (Valenciennes), CREOLE FISH, occasional, UMML.
- \*Petrometopon cruentatum (Lacépède), GRAYSBY, common, UMML.
- \*Schultzetta beta (Hildebrand), SCHOOL BASS, frequent, UMML.
- \*Serraniculus pumilio Ginsburg, PYGMY SEA BASS, rare, UMML.
- \*Serranus annularis (Günther), ORANGEBACK BASS, common, UMML.
- \*Serranus atrobranchus (Cuvier), BLACKEAR BASS, rare, offshore, UMML.
- \*Serranus baldwini (Evermann and Marsh), LANTERN BASS, common, UMML.
- \*Serranus chionarala Robins and Starck, SNOW BASS, occasional, UMML.
- \*Serranus notospilus Longley, SADDLE BASS, occasional, UMML.
- \*Serranus phoebe Poey, TATTLER, common, UMML.
- \*Serranus tabacarius (Cuvier), TOBACCO FISH, common, UMML.
- \*Serranus tigrinus (Bloch), HARLEQUIN BASS, common, UMML.
- \*Serranus tortugarum Longley, CHALK BASS, common, UMML.

#### LOBOTIDAE - TRIPLETAILS

- Lobotes surinamensis (Bloch), TRIPLETAIL, occasional both offshore and in-shore, UMML.

#### GRAMMISTIDAE - SOAPFISHES

- \*Pseudogrammus gregoryi (Breder), REEF BASS, occasional, UMML.  
P. bermudensis (Kanazawa) and P. brederi (Hildebrand) are considered here to be junior synonyms.
- \*Rypticus bistrisplius (Mitchill), FRECKLED SOAPFISH, occasional, UMML.  
The name used here is that recommended by Walter R. Courtenay in his manuscript review of the genus. This species was previously known as Rypticus arenatus.
- \*Rypticus saponaceus (Bloch and Schneider), SOAPFISH, frequent, UMML.
- \*Rypticus subblfrenatus Gill, SPOTTED SOAPFISH, common, UMML.  
Included by Bailey et al. (1960) but not previously recorded from U.S. waters.

#### CIRRHITIDAE - HAWKFISHES

- \*Amblycirrhitis pinos (Mowbray), CARIBBEAN HAWKFISH, frequent, UMML.

## LUTJANIDAE - SNAPPERS

Apsilus dentatus Gulchenot, BLACK SNAPPER, rare, offshore, UMML.  
Included by Bailey et al. (1960) but apparently not previously recorded from U.S. waters.

- \*Lutjanus analls (Cuvier), MUTTON SNAPPER, common, UMML.
- \*Lutjanus apodus (Walbaum), SCHOOLMASTER, abundant, UMML.
- Lutjanus campechanus (Poey), RED SNAPPER, occasional, offshore, UMML.
- +Lutjanus buccanella (Cuvier), BLACKFIN SNAPPER, frequent, juveniles only, UMML.
- \*Lutjanus cyanopterus (Poey), CUBERA SNAPPER, occasional, UMML.
- +Lutjanus griseus (Linnaeus), GRAY OR MANGROVE SNAPPER, abundant, UMML.
- \*Lutjanus jocu (Bloch and Schneider), DOG SNAPPER, frequent, UMML.
- \*Lutjanus mahogoni (Cuvier), MAHOGANY SNAPPER, occasional, UMML.
- +Lutjanus synagris (Linnaeus), LANE SNAPPER, frequent, UMML.
- +Lutjanus vivanus (Cuvier), SILK SNAPPER, occasional, juveniles only, UMML.
- \*Ocyurus chrysurus (Bloch), YELLOWTAIL, abundant, UMML.

## PRIACANTHIDAE - BIGEYES

- \*Priacanthus arenatus Cuvier, BIGEYE, rare, UMML.
- \*Priacanthus cruentatus (Lacépède), GLASSEYE SNAPPER, frequent, UMML.
- +Pristigeyns alta (Gill), SHORT BIGEYE, occasional, UMML.

## APOGONIDAE - CARDINALFISHES

- \*Apogon aurolineatus (Mowbray), BRIDLE CARDINALFISH, occasional, UMML.
- \*Apogon binotatus (Poey), BARRED CARDINALFISH, frequent, UMML.
- \*Apogon conklini (Silvester), FRECKLED CARDINALFISH, common, UMML.
- \*Apogon lachneri Böhlke, WHITESTAR CARDINALFISH, frequent, UMML.  
Included by Bailey et al. (1960) but not previously recorded from U.S. waters.
- \*Apogon maculatus (Poey), FLAMEFISH, abundant, UMML.
- \*Apogon pigmentarius (Poey), DUSKY CARDINALFISH, occasional, UMML.
- \*Apogon sp., SADDLETAIL CARDINALFISH, rare, UMML. A new species to be described by Böhlke and Randall under the species name pillionatus.
- \*Apogon planifrons Longley and Hildebrand, PALE CARDINALFISH, frequent, UMML.
- \*Apogon pseudomaculatus Longley, TWOSPOT CARDINALFISH, frequent, UMML.
- \*Apogon quadriscquamatus Longley, SAWCHEEK CARDINALFISH, frequent, UMML.
- \*Apogon townsendi (Breder), BELTED CARDINALFISH, occasional, UMML.  
Included by Bailey et al. (1960) but apparently not previously recorded from U.S. waters.
- \*Apogon sp., SPONGE CARDINALFISH, rare, UMML. A new species to be described by Böhlke and Randall under the species name xenus.
- \*Astrapogon alutus (Jordan and Gilbert), BRONZE CARDINALFISH, occasional, UMML.
- \*Astrapogon punctulatus (Poey), BLACKFIN CARDINALFISH, frequent, UMML.
- \*Astrapogon stellatus (Cope), CONCHFISH, occasional, UMML.
- \*Chelodipterus affinis Poey, BIGTOOTH CARDINALFISH, occasional, UMML.  
First record for Florida.
- Synagrops bella (Goode and Bean), DEEPSEA CARDINALFISH, common, offshore, UMML.

## BRANCHIOSTEGIDAE - TILEFISHES

Caulolatilus cyanops Poey, BLACKLINE TILEFISH, common, offshore, UMML.

Lopholatilus chamaeleonticeps Goode and Bean, TILEFISH, rare, offshore, UMML.

\*Malacanthus plumieri (Bloch), SAND TILEFISH, common, UMML.

#### POMATOMIDAE - BLUEFISHES

Pomatomus saltatrix (Linnaeus), BLUEFISH, occasional in winter.

#### RACHYCENTRIDAE - COBIAS

Rachycentron canadum (Linnaeus), COBIA, occasional, reef and offshore.

#### CARANGIDAE - JACKS

+Alectis crinitus (Mitchill), AFRICAN POMPAÑO, frequent, UMML.

\*Caranx bartholomaei Cuvier, YELLOW JACK, common, UMML.

+Caranx fusus Geoffrey, BLUE RUNNER, common, UMML.

+Caranx hippos (Linnaeus), CREVALLE JACK, frequent, common inshore, UMML.

+Caranx latus Agassiz, HORSE-EYE JACK, frequent, UMML.

\*Caranx ruber (Bloch), BAR JACK, common, UMML.

Chloroscombrus chrysurus (Linnaeus), BUMPER, occasional, slight record only.

+Decapterus punctatus (Agassiz), ROUND SCAD, frequent, UMML.

\*Elagatis bipinnulatus (Quoy and Gaimard), RAINBOW RUNNER, frequent, UMML.

Oligoplites saurus (Bloch and Schneider), LEATHERJACKET, frequent, inshore.

+Selar crumenophthalmus (Bloch), BIGEYE SCAD, occasional, UMML.

Selene vomer (Linnaeus), LOOKDOWN, common, inshore, UMML.

+Seriola dumerilii (Risso), AMBERJACK, common, UMML.

Seriola rivoliana Valenciennes, ALMACO JACK, frequent, offshore, UMML.

Seriola zonata (Mitchill), BANDED RUDDERFISH, rare, offshore.

Trachinotus carolinus (Linnaeus), POMPAÑO, frequent, inshore, UMML.

+Trachinotus falcatus (Linnaeus), PERMIT, frequent.

+Trachurus lathamii Nichols, ROUGH SCAD, occasional, UMML.

Vomer setapinnis (Mitchill), MOONFISH, rare, UMML.

#### CORYPHAENIDAE - DOLPHINS

Coryphaena equisetis Linnaeus, POMPAÑO DOLPHIN, occasional to frequent, offshore, UMML.

Coryphaena hippurus Linnaeus, DOLPHIN, common, offshore, UMML.

#### GERREIDAE - MOJARRAS

+Euclinostomus argenteus Baird and Girard, SLENDER MOJARRA, common, UMML.

+Euclinostomus gula (Quoy and Gaimard), SILVER JENNY, common, UMML.

+Gerres cinereus (Walbaum), YELLOWFIN MOJARRA, frequent, reef, common inshore, UMML.

#### POMADASYIDAE - GRUNTS

\*Anisotremus surinamensis (Bloch), BLACK MARGATE, common, UMML.

\*Anisotremus virginicus (Linnaeus), PORKFISH, common, UMML.

\*Haemulon album Cuvier, MARGATE, common, UMML.

\*Haemulon quolineatum Cuvier, TOMTATE, abundant, UMML.

\*Haemulon carbonarium Poey, CAESAR GRUNT, common, UMML.

\*Haemulon chrysargyreum Günther, SMALLMOUTH GRUNT, abundant, UMML.

\*Haemulon flavolineatum (Desmarest), FRENCH GRUNT, abundant, UMML.

\*Haemulon macrostomum Günther, SPANISH GRUNT, common, UMML.

- \*Haemulon melanurum (Linnaeus), COTTONWICK, occasional to frequent, UMML.
- \*Haemulon parra (Desmarest), SAILORS CHOICE, common, UMML.
- \*Haemulon plumieri (Lacépède), WHITE GRUNT, abundant, UMML.
- \*Haemulon sclurus (Shaw), BLUESTRIPED GRUNT, abundant, UMML.
- \*Haemulon striatum (Linnaeus), SMALLMOUTH TOMTATE, abundant, UMML.
- Orthopristis chrysopterus (Linnaeus), PIGFISH, rare, Inshore.

#### SCIAENIDAE - DRUMS

- +Bairdiella batabana (Poey), BLUE CROAKER, occasional, UMML.
- \*Equetus acuminatus (Bloch and Schneider), HIGH-HAT, common, UMML.  
As used here acuminatus applies to the species formerly known as pulcher and the species formerly known as acuminatus is umbrosus. This change is based on the unpublished recommendation of George Miller. The common names used here and for E. punctatus differ from those suggested by Bailey et al. (1960) in accordance with popular usage.
- \*Equetus lanceolatus (Linnaeus), JACKKNIFE-FISH, occasional, UMML.
- \*Equetus punctatus (Bloch and Schneider), SPOTTED HIGH-HAT, occasional, UMML. Included by Briggs (1958) and Bailey et al. (1960) but not previously recorded from U.S. waters.
- +Equetus umbrosus Jordan and Eigenmann, CUBBYU, occasional, UMML.
- \*Odontoscia dentex (Cuvier), REEF CROAKER, common, UMML.
- Sciaenops ocellata (Linnaeus), RED DRUM OR CHANNEL BASS, occasional, Inshore.

#### MULLIDAE - GOATFISHES

- \*Mullidichthys martinicus (Cuvier), YELLOW GOATFISH, common, UMML.
- \*Pseudupeneus maculatus (Bloch), SPOTTED GOATFISH, common, UMML.

#### SPARIDAE - PORGIES

- Archosargus probatocephalus (Walbaum), SHEEPSHEAD, frequent, Inshore, UMML.
- +Archosargus rhomboidalis (Linnaeus), SEA BREAM, frequent, UMML.
- +Calamus arctifrons Goode and Bean, GRASS PORGY, occasional, UMML.
- +Calamus bajonado (Bloch and Schneider), JOLTHEAD PORGY, occasional, UMML.
- \*Calamus calamus (Valenciennes), SAUCEREYE PORGY, frequent, UMML.
- +Calamus nodosus Randall and Caldwell, KNOBBED PORGY, frequent, UMML.
- +Calamus prolidens Jordan and Gilbert, LITTLEHEAD PORGY, common, UMML.
- Lagodon rhomboides (Linnaeus), PINFISH, abundant, Inshore, UMML.

#### EMMELICHTHYIDAE - BOGAS

- \*Emmelichthys atlanticus Schultz, LITTLE BOGA, frequent, UMML.
- \*Inermia vittata Poey, BOGA, occasional, UMML. First record for Florida.

#### PEMPHERIDAE - SWEEPERS

- \*Pempheris schomburgkii Müller and Troschel, GLASSY SWEEPER, common, UMML.

#### KYPHOSIDAE - SEA CHUBS

- \*Kyphosus incisus (Cuvier), YELLOW CHUB, common, UMML.
- \*Kyphosus sectatrix (Linnaeus), BERMUDA CHUB, frequent, common Inshore, UMML.

#### EPHIPPIDAE - SPADEFISHES

- +Chaetodipterus faber (Broussonet), SPADEFISH, frequent to common, UMML.

## CHAETODONTIDAE - BUTTERFLYFISHES AND ANGELFISHES

- \*Centropyge argi Woods and Kanazawa, PYGMY ANGELFISH, occasional, UMML.  
Included by Briggs (1958) and Bailey et al. (1960) but not recorded previously from U.S. waters. Pygmy angelfish rather than cherubfish (Bailey et al.) is in wide use by aquarists.
- \*Chaetodon capistratus Linnaeus, FOUREYED BUTTERFLYFISH, common, UMML.
- \*Chaetodon ocellatus Bloch, COMMON BUTTERFLYFISH, common, UMML.  
Common butterflyfish rather than spotfin butterflyfish (Bailey et al., 1960) is widely used by aquarists and skindivers. The spot is frequently absent in the day.
- \*Chaetodon sedentarius Poey, REEF BUTTERFLYFISH, common, UMML.
- \*Chaetodon striatus Linnaeus, BANDED BUTTERFLYFISH, common, UMML.
- \*Holacanthus ciliaris (Linnaeus), QUEEN ANGELFISH, common, UMML.
- \*Holacanthus isabellita (Jordan and Rutter), BLUE ANGELFISH, common, UMML.
- \*Holacanthus tricolor (Bloch), ROCK BEAUTY, common, UMML.
- \*Pomacanthus arcuatus (Linnaeus), BLACK ANGELFISH, common, UMML.  
The species name arcuatus as used here applies to the species called glaucus by most previous authors. Likewise paru as used here equals arcuatus of previous authors. This nomenclature and the use of isabellita for the blue angelfish has been recommended by Henry A. Feddern (personal communication) who is reviewing the Western Atlantic angelfishes. The common name black angelfish rather than gray angelfish (Bailey et al., 1960) is again a widely used name by aquarists, skindivers, and fishermen while gray angelfish is not.
- \*Pomacanthus paru (Bloch), FRENCH ANGELFISH, common, UMML.
- \*Prognathodes aculeatus (Poey), LONGSNOUT BUTTERFLYFISH, occasional, UMML. Included by Bailey et al. (1960) but not previously recorded from U.S. waters. Subsequently recorded by Hubbs (1963).

## POMACENTRIDAE - DAMSELFISHES

- \*Abudefduf saxatilis (Linnaeus), SERGEANT MAJOR, abundant, UMML.
- +Abudefduf taurus (Müller and Troschel), NIGHT SERGEANT, rare, Inshore, UMML.
- \*Chromis cyanea (Poey), BLUE CHROMIS, abundant, UMML. Included by Bailey et al. (1960) but not previously reported. (Figures 6 and 7)
- \*Chromis enchrysurus Jordan and Gilbert, YELLOWTAIL REEF-FISH, abundant, UMML. (Figure 8)
- \*Chromis insolatus (Cuvier), SUNSHINE FISH, abundant, UMML. (Figure 9)  
The common names of this species and of Chromis multilineata, Microspathodon chrysurus, and Eupomacentrus planifrons below are in accordance with usage by aquarists and skindivers. Bailey et al. (1960) offer other names.
- \*Chromis multilineata (Gulichenot), GRAY CHROMIS, abundant, UMML. (Figures 10 and 11)
- +Chromis sp., PURPLE REEF-FISH, common, UMML. An undescribed species closely related to Chromis insolatus. (Figures 12 and 13)  
This species will be described in a forthcoming paper by Alan R. Emery under the species name scottii.
- \*Eupomacentrus fuscus (Cuvier), DUSKY DAMSELFISH, common, UMML. (Figures 14 and 15)
- \*Eupomacentrus leucostictus (Müller and Troschel), BEAUGREGORY, common, UMML. (Figure 16)

- \*Eupomacentrus sp., HONEY GREGORY, frequent, UMML. An undescribed species close to E. leucostictus. (Figure 17) This species will be described in a forthcoming paper by Alan R. Emery under the species name mellis.
- \*Eupomacentrus partitus (Poey), BICOLOR DAMSELFISH, abundant, UMML. (Figures 18, 19, and 20)
- \*Eupomacentrus planifrons (Cuvier), YELLOW DAMSELFISH, common, UMML. (Figure 21)
- \*Eupomacentrus varillalis (Castelnau), COCOA DAMSELFISH, abundant, UMML. (Figure 22)
- \*Microspathodon chrysurus (Cuvier), JEWELFISH, common, UMML. (Figures 23 and 24)

#### LABRIDAE - WRASSES

- \*Bodianus pulchellus (Poey), SPOTFIN HOGFISH, common, UMML. Included by Bailey et al. (1960) but not previously recorded from U.S. waters. Subsequently recorded by Randall (1962).
- \*Bodianus rufus (Linnaeus), SPANISH HOGFISH, common, UMML.
- \*Clepticus parra (Bloch and Schneider), CREOLE WRASSE, common, UMML. Included by Bailey et al. (1960) but not previously recorded from U.S. waters.
- Decodon puellaris (Poey), CUBAN HOGFISH, common, offshore, UMML.
- \*Doratonotus megalepis Günther, DWARF WRASSE, common, UMML.
- \*Hallchoeres bathyphilus (Beebe and Tee-Van), GREENBAND WRASSE, rare, UMML. Included by Bailey et al. (1960) but not previously recorded from U. S. waters. Subsequently recorded by Randall and Böhlke (1965).
- \*Hallchoeres bivittatus (Bloch), SLIPPERY DICK, abundant, UMML.
- \*Hallchoeres caudalis (Poey), PAINTED WRASSE, occasional, UMML.
- \*Hallchoeres cyanocephalus (Bloch), YELLOWBACK WRASSE, frequent, UMML.
- \*Hallchoeres garnoti (Valenciennes), YELLOWHEAD WRASSE, abundant, UMML.
- \*Hallchoeres maculipinna (Müller and Troschel), CLOWN WRASSE, abundant, UMML.
- \*Hallchoeres pictus (Poey), STRIPED WRASSE, frequent, UMML. First record for Florida.
- \*Hallchoeres poeyi (Steindachner), BLACKEAR WRASSE, common, UMML.
- \*Hallchoeres radiatus (Linnaeus), PUDDINGWIFE, common, UMML.
- \*Hemipteronotus martinicensis (Valenciennes), ROSY RAZORFISH, frequent, UMML. Randall (1965b: 499) has pointed out that the Xyrichtys martinicensis of Longley and Hildebrand (1941) is Hemipteronotus splendens, thus H. martinicensis is previously unrecorded from Florida. Inclusion by Briggs (1958) and Bailey et al. (1960) is apparently based on Longley and Hildebrand (1941).
- \*Hemipteronotus novacula (Linnaeus), PEARLY RAZORFISH, common, UMML.
- \*Hemipteronotus splendens (Castelnau), GREEN RAZORFISH, common, UMML.
- \*Lachnolaimus maximus (Walbaum), HOGFISH, common, UMML.
- \*Thalassoma bifasciatum (Bloch), BLUEHEAD WRASSE, abundant, UMML.

#### SCARIDAE - PARROTFISHES

- \*Cryptotomus roseus Cope, BLUELIP PARROTFISH, common, UMML.
- \*Nicholsina usta (Valenciennes), EMERALD PARROTFISH, frequent, UMML.
- \*Scarus coelestinus Valenciennes, INDIGO PARROTFISH, common, UMML.  
The common names used here and for Sparisoma rubripinne differ from those used by Bailey et al. (1960) in order to conform to widespread usage.
- \*Scarus coeruleus (Bloch), BLUE PARROTFISH, common, UMML.

- \*Scarus croticensis Bloch, STRIPED PARROTFISH, common, UMML.
- \*Scarus guacamala Cuvier, RAINBOW PARROTFISH, common, UMML.
- \*Scarus taeniopterus Desmarest, RIBBON PARROTFISH, frequent, UMML.  
Not included by Briggs (1958) or Bailey et al. (1960) as the name was in synonymy with Scarus croticensis at that time. Randall (1963a: 228) has pointed out the validity of this species. Breder (1948) correctly identified the male of Scarus taeniopterus and stated that it reaches Florida.
- \*Scarus vetula Bloch and Schneider, QUEEN PARROTFISH, common, UMML.
- \*Sparisoma atomarium (Poey), DEEPWATER PARROTFISH, common, UMML.
- \*Sparisoma aurofrenatum (Valenciennes), WHITESPOT PARROTFISH, common, UMML. The common names suggested by Bailey et al. (1960) for this species and for S. chrysopterus and S. viride are not in wide usage and are misleading for the live fish; therefore, other names are suggested here.
- \*Sparisoma chrysopterus (Bloch and Schneider), TURQUOISE PARROTFISH, frequent, UMML.
- \*Sparisoma radians (Valenciennes), BUCKTOOTH PARROTFISH, common, UMML.
- \*Sparisoma rubripinne (Valenciennes), MUD PARROTFISH, common, UMML.
- \*Sparisoma viride (Bonnaterre), GREEN PARROTFISH, common, UMML.

## ACANTHURIDAE - SURGEONFISHES

- \*Acanthurus bahianus Castelnau, OCEAN SURGEON, common, UMML.
- \*Acanthurus chirurgus (Bloch), DOCTORFISH, common, UMML.
- \*Acanthurus coeruleus Bloch and Schneider, BLUE TANG, common, UMML.

## GEMPYLIDAE - SNAKE MACKERELS

- Gempylus serpens Cuvier, SNAKE MACKEREL, rare, offshore, UMML.

## SCOMBRIDAE - MACKERELS AND TUNAS

- Acanthocybium solanderi (Cuvier), WAHOO, occasional, offshore.
- Axylus thazard (Lacépède), FRIGATE MACKEREL, occasional, offshore, UMML.
- Euthynnus alletteratus (Rafinesque), LITTLE TUNA, common, offshore, UMML.
- Euthynnus pelamis (Linnaeus), SKIPJACK OR ARTIC BONITO, common, offshore, UMML.
- +Scomberomorus cavalla (Cuvier), KING MACKEREL, abundant in winter, UMML.
- Scomberomorus maculatus (Mitchill), SPANISH MACKEREL, frequent to abundant in winter.
- +Scomberomorus regalis (Bloch), CERO, common, UMML.
- Thunnus albacares (Bonnaterre), YELLOWFIN TUNA, frequent, offshore, UMML.
- Thunnus atlanticus (Lesson), BLACKFIN TUNA, common, offshore, UMML.
- Thunnus thynnus (Linnaeus), BLUEFIN TUNA, occasional, juveniles only, offshore, UMML.

## ISTIOPHORIDAE - BILLFISHES

- Istiophorus platypterus (Shaw and Nodder), SAILFISH, common, offshore, UMML. This name follows Whitehead's (1964) paper pointing out platypterus as the earliest available name for a sailfish (from the Indian Ocean) and James E. Morrow's unpublished study of the genus Istiophorus placing all nominal forms in one worldwide species.
- Makaira nigricans Lacépède, BLUE MARLIN, occasional, offshore, UMML.
- Tetrapturus albidus Poey, WHITE MARLIN, occasional, offshore.

Tetraodon pfluger Robins and deSylva, LONGBILL SPEARFISH, rare, offshore.

#### XIPHIIDAE - SWORDFISHES

Xiphias gladius Linnaeus, SWORDFISH, rare, offshore.

#### ELEOTRIDAE - SLEEPERS

\*Toglossus callurus Bean, BLUE SLEEPER, common, UMML.

#### Gobiidae - GOBIES

+Barbullifer ceuthoecus (Jordan and Gilbert), BEARDED GOBY, frequent, UMML.

Bathygobius mystacium Ginsburg, TIDEPOOL GOBY, rare, Inshore, UMML.  
First record for Florida.

Bathygobius soporator (Valenciennes), FRILLFIN GOBY, common, Inshore, UMML.

\*Coryphopterus alioides Böhlke and Robins, SPLITFIN GOBY, rare, UMML.  
First record for Florida.

\*Coryphopterus dircus Böhlke and Robins, DOUBLESPOT GOBY, common, UMML.

\*Coryphopterus eldalon Böhlke and Robins, GHOST GOBY, common, UMML.

+Coryphopterus glaucofraenum Gill, BRIDLED GOBY, common, UMML.

\*Coryphopterus hyalinus Böhlke and Robins, GLASS GOBY, occasional, UMML.

\*Coryphopterus lpernes Böhlke and Robins, BLUENOSE GOBY, frequent, UMML.

\*Coryphopterus personatus (Jordan and Thompson), MASKED GOBY, abundant, UMML.

+Coryphopterus punctipectorphorus Springer, SPOTTED GOBY, frequent, UMML.

\*Coryphopterus thrix Böhlke and Robins, BARTAIL GOBY, occasional, UMML.  
First record for Florida.

\*Elacatinus oceanops Jordan, NEON GOBY, common, UMML.

\*Gammamia grosvenori Robins, DWARF SAND GOBY, occasional, UMML.

+Gammamia macrodon (Beebe and Tee-Van), TIGER GOBY, frequent, UMML.

\*Gnatholepis thompsoni Jordan, GOLDSPOOT GOBY, common, UMML.

Goblonellus boleosoma (Jordan and Gilbert), DARTER GOBY, occasional, Inshore, UMML.

\*Goblonellus sp., DASH GOBY, frequent, UMML. An undescribed species.

To be described by Gilbert and Randall under the species name saepepallens.

+Goblonellus stigmatophyllus Mead and Böhlke, SPOTGIN GOBY, frequent, UMML.

Gobiosoma robustum Ginsburg, CODE GOBY, frequent, Inshore.

\*Gobiosoma sp., YELLOWLINE GOBY, rare, UMML. This species has formerly been identified as G. horsti which does not occur in Florida.

It will be described by Böhlke and Robins under the species name xanthipone.

\*Lythrypnus neslotes Böhlke and Robins, ISLAND GOBY, rare, UMML.  
First record for Florida.

\*Lythrypnus phorellus Böhlke and Robins, PRISONER GOBY, frequent, UMML.

\*Lythrypnus splius Böhlke and Robins, DARKSHOULDER GOBY, frequent, UMML.

\*Microgobius carri Fowler, SEMINOLE GOBY, common, UMML.

\*Nes longus (Nichols), ORANGESPOTTED GOBY, occasional, UMML. Placement of this species in the genus Nes is done on the unpublished recommendation of C. Richard Robins.

\*Quisquilius hipolit (Metzelaar), REEF GOBY, common, UMML.

## MICRODESMIDAE - WORMFISHES

- \*Microdesmus floridanus (Longley), PUGJAW WORMFISH, occasional, UMML.

## SCORPAENIDAE - SCORPIONFISHES

- Pontinus rathbuni Goode and Bean, HIGHFIN SCORPIONFISH, occasional, offshore, UMML.  
Scorpaena agassizi Goode and Bean, LONGFIN SCORPIONFISH, frequent, offshore, UMML.  
 \*Scorpaena albifimbria Evermann and Marsh, CORAL SCORPIONFISH, rare, UMML.  
 \*Scorpaena bergi Evermann and Marsh, GOOSEHEAD SCORPIONFISH, occasional, UMML.  
 +Scorpaena calcarata Goode and Bean, SMOOTHHEAD SCORPIONFISH, frequent, UMML.  
 +Scorpaena dispar Longley and Hildebrand, HUNCHBACK SCORPIONFISH, occasional, UMML.  
 \*Scorpaena elachys Eschmeyer, DWARF SCORPIONFISH, rare, UMML.  
 +Scorpaena grandicornis Cuvier, PLUMED SCORPIONFISH, occasional, UMML.  
 This name rather than "lionfish" of Bailey et al. (1960) is used to avoid confusion with the Indo-Pacific lionfish (Pterois).  
 \*Scorpaena inermis Cuvier, MUSHROOM SCORPIONFISH, occasional, UMML.  
 \*Scorpaena plumieri Bloch, SPOTTED SCORPIONFISH, frequent, UMML.  
 \*Scorpaenodes caribbaeus Meek and Hildebrand, REEF SCORPIONFISH, frequent, UMML. (Figure 25)  
 \*Scorpaenodes tridecimspinosus (Metzelaar), DEEPREEF SCORPIONFISH, occasional, UMML. First record for Florida. (Figure 26)

## TRIGLIDAE - SEAROBINS

- Bellator brachyichir (Regan), SHORTFIN SEAROBIN, common, offshore, UMML.  
Bellator egretta (Goode and Bean), STREAMER SEAROBIN, offshore, UMML.  
Bellator militaris (Goode and Bean), HORNED SEAROBIN, abundant, offshore, UMML.  
Peristedion gracile Goode and Bean, SLENDER SEAROBIN, offshore.  
 The record of this species was kindly furnished by George Miller.  
Peristedion platycephalum (Goode and Bean), FLATHEAD SEAROBIN, offshore, UMML.  
Prionotus alatus Goode and Bean, SPINY SEAROBIN, offshore, UMML.

## DACTYLOPTERIDAE - FLYING GURNARDS

- +Dactylopterus volitans (Linnaeus), FLYING GURNARD, occasional, UMML.

## OPISTHOGNATHIDAE - JAWFISHES

- +Lonchopisthus lindneri Ginsburg, SWORDTAIL JAWFISH, rare, UMML.  
 \*Opisthognathus aurifrons (Jordan and Thompson), YELLOWHEAD JAWFISH, common, UMML.  
 \*Opisthognathus cuvieri Valenciennes, PHANTOM JAWFISH, rare, UMML.  
 First record for Florida.  
 +Opisthognathus lonchurus Jordan and Gilbert, MOUSTACHE JAWFISH, frequent, UMML. Longtail jawfish of Bailey et al. (1960) does not appear appropriate for this fish.  
 +Opisthognathus macrognathus Poey, LONGJAW JAWFISH, occasional, UMML.  
 \*Opisthognathus whitehursti (Longley), DUSKY JAWFISH, common, UMML.

## DACTYLOSCOPIDAE - SAND STARGAZERS

- +Dactyloscopus tridigitatus Gill, SAND STARGAZER, occasional, UMML.
- \*Girellus greyae Kanazawa, ARROW STARGAZER, frequent, UMML.
- \*Heteristius rubroinctus (Longley), SADDLE STARGAZER, common, UMML.

## CALLIONYMIDAE - DRAGONETS

- Callionymus agassizii Goode and Bean, LANCER DRAGONET, common, offshore, UMML.
- \*Callionymus balradi Jordan, CORAL DRAGONET, frequent, UMML.
- +Callionymus pauciradiatus Gill, SPOTTED DRAGONET, occasional, UMML.

## CLINIDAE - CLINIDS

- \*Acanthemblemaria aspera (Longley), ROUGHHEAD BLENNY, common, UMML.
- +Chaenopsis ocellata Poey, BLUE THROAT PIKEBLENNY, rare, UMML.
- \*Chaenopsis ilimbaughii Robins and Randall, SAND PIKEBLENNY, occasional, UMML. First record for Florida.
- \*Emblemaria atlantica Jordan and Evermann, BANNER BLENNY, occasional, UMML.
- \*Emblemaria pandionis Evermann and Marsh, SAILFIN BLENNY, occasional, UMML.
- \*Emblemaropsis bottomel Stephens, MIDNIGHT BLENNY, occasional, UMML. First record for Florida.
- \*Emblemaropsis diaphana Longley, GLASS BLENNY, occasional, UMML.
- \*Enneanectes altivelis Rosenblatt, LOFTY BLENNY, common, UMML. First record for Florida.
- \*Enneanectes boehlkei Rosenblatt, BÖHLKE'S BLENNY, frequent, UMML.
- \*Enneanectes pectoralis (Fowler), REDEYE BLENNY, frequent, UMML.
- \*Hemiblemaria simulus Longley and Hildebrand, WRASSE BLENNY, frequent, UMML.
- \*Labrisomus bucciferus (Poey), FRECKLECHEEK BLENNY, rare, UMML. First record for Florida.
- \*Labrisomus goble (Valenciennes), PALEHEAD BLENNY, rare, UMML. First record for Florida.
- \*Labrisomus guppyi (Norman), MIMIC BLENNY, frequent, UMML.
- \*Labrisomus hatlensis Beebe and Tee-Van, HATIAN BLENNY, common, UMML. Not listed by Bailey et al. (1960) but included for Florida by Longley and Hildebrand (1941), Briggs (1958), and Springer (1958).
- \*Labrisomus kallisherae (Jordan), DOWNY BLENNY, frequent, UMML.
- \*Labrisomus nigricinctus Howell Rivero, SPOTCHEEK BLENNY, occasional, UMML.
- \*Labrisomus nuchipinnis (Quoy and Gaimard), HAIRY BLENNY, common, UMML.
- \*Malacoctenus aurolineatus Smith, ORANGELINE BLENNY, occasional, UMML. Not listed by Bailey et al. (1960) but recorded from Florida by Springer (1958). Malacoctenus sp. of Briggs (1958) is possibly this species.
- \*Malacoctenus macropus (Poey), ROSY BLENNY, frequent, UMML.
- \*Malacoctenus triangulatus Springer, SADDLED BLENNY, common, UMML.
- +Paraclinus fasciatus (Steindachner), BANDED BLENNY, abundant, UMML.
- \*Paraclinus grandicomis (Rosen), HORNED BLENNY, occasional, UMML.
- \*Paraclinus infrons Böhlke, LONGNOSE BLENNY, rare, UMML. First record for Florida.
- +Paraclinus marmoratus (Steindachner), MARBLED BLENNY, occasional, UMML.
- \*Paraclinus nigripinnis (Steindachner), BLACKFIN BLENNY, abundant, UMML.
- \*Starksia ocellata (Steindachner), CHECKERED BLENNY, common, UMML.

- \*Stathmonotus hemphilli Bean, CLOWN BLENNY, occasional, UMML.

#### BLENNIIDAE - COMBTOOTH BLENNIES

- +Blennius cristatus Linnaeus, MULLY MILLER, abundant inshore, occasional reef, UMML.  
 \*Blennius marmoratus Poey, SEAWEED BLENNY, common, UMML.  
 +Entomacrodus textilis (Quoy and Gaimard), PEARL BLENNY, common, UMML.  
 \*Hypoleurochilus bermudensis Beebe and Tee-Van, BARRED BLENNY, common, UMML.  
 \*Ophioblennius atlanticus (Valenciennes), REDLIP BLENNY, common, UMML.

#### BROTULIDAE - BROTLAS

- +Brotula barbata (Bloch and Schneider), BEARDED BROTLA, rare, UMML.  
 \*Ogilbia caryorum Evermann and Kendall, KEY BROTLA, common, UMML.  
 It is generally accepted among systematists that a number of species are now classified under this name. The identification is, therefore, tentative and it is probable that more than one species is found at Alligator Reef.  
 \*Oligopus claudel (Torre), REEF BROTLA, rare, UMML. First record for Florida.  
 \*Petrotyx sanguineus (Meek and Hildebrand), RUDDY BROTLA, frequent, UMML. First record for Florida.  
 \*Stygnobrotula latebricola Böhlke, BLACK BROTLA, rare, UMML. First record for Florida.

#### OPHIIDAE - CUSK-EELS

- +Lepophidium jeannae Fowler, MOTTLED CUSK-EEL, rare, UMML.  
 +Ophidion hoibrooki (Putnam), BANK CUSK-EEL, occasional, UMML.  
 +Ophidion selenops Robins and Böhlke, MOONEYE CUSK-EEL, occasional, UMML.  
 \*Ophidion dormitator Böhlke and Robins, GHOST CUSK-EEL, occasional, UMML. First record for Florida.  
 \*Parophidion schmidt (Woods and Kanazawa), GRASS CUSK-EEL, frequent, UMML. First record for Florida.

#### CARAPIDAE - PEARLFISHES

- \*Carapus bermudensis (Jones), PEARLFISH, frequent, UMML.

#### STROMATEIDAE - BUTTERFISHES

- Ariomma regulus (Poey), SPOTTED DRIFTFISH, rare, offshore, UMML.  
Nomeus gronowii (Gmelin), MAN-O-WAR FISH, frequent, UMML.  
Parinurichthys percliformis (Mitchill), BARRELFISH, rare, offshore.  
Psenes cyanophrys Cuvier, FRECKLED DRIFTFISH, occasional, offshore, UMML.  
Psenes maculatus Lütken, SILVER DRIFTFISH, occasional, offshore, UMML.

#### SPHYRAENIDAE - BARRACUDAS

- \*Sphyraena barracuda (Walbaum), GREAT BARRACUDA, common, UMML.  
 +Sphyraena borealis DeKay, NORTHERN BARRACUDA, frequent, UMML.  
 This common name differs from that of Bailey *et al.* (1960) in accordance with general usage.

#### MUGILIDAE - MULLET

- Mugil cephalus Linnaeus, STRIPED OR BLACK MULLET, common, inshore.  
Mugil curema Valenciennes, WHITE MULLET, frequent, inshore.

Mugil galmardiana Desmarest, REDEYE MULLET, occasional, Inshore.  
Mugil trichodon Poey, FANTAIL MULLET, abundant, Inshore, UMML.

#### ATHERINIDAE - SILVERSIDES

+Allanetta harringtonensis (Goode), REEF SILVERSIDE, common, UMML.  
 +Atherinomoros stipes (Müller and Troschel), HARDHEAD SILVERSIDE, common, UMML.

#### BOTHIDAE - LEFT EYE FLOUNDERS

Ancylopsetta dillecta (Goode and Bean), THREE-EYE FLOUNDER, offshore, UMML.  
 \*Bothus ocellatus (Agassiz), EYED FLOUNDER, common, UMML.  
Clitharichthys arctifrons Goode, GULF STREAM FLOUNDER, abundant, offshore, UMML.  
Clitharichthys cornutus (Günther), HORNED WHIFF, abundant, offshore, UMML.  
 +Clitharichthys macrops Dresel, SPOTTED WHIFF, occasional, UMML.  
 +Clitharichthys sp., rare, UMML. An unidentified species close to C. cornutus, possibly undescribed.  
 +Cyclopsetta fimbriata (Goode and Bean), SPOTFIN FLOUNDER, occasional, UMML.  
 +Syacium gunteri Ginsburg, CHANNEL FLOUNDER, occasional, UMML.  
 +Syacium papillosum (Linnaeus), DUSKY FLOUNDER, common, UMML.

#### SOLEIDAE - SOLES

+Achirus lineatus (Linnaeus), LINED SOLE, rare, UMML.  
 +Trinectes maculatus (Bloch and Schneider), HOGCHOKER, rare, UMML.

#### CYNOGLOSSIDAE - TONGUEFISHES

\*Symphurus arawak Robins and Randall, CARIBBEAN TONGUEFISH, rare, UMML. First record for Florida.  
 +Symphurus diomedianus (Goode and Bean), SPOTTEDFIN TONGUEFISH, occasional, UMML.

#### ECHENEIDAE - REMORAS

+Echeneis naucrates Linnaeus, SHARKSUCKER, common, UMML.  
 +Echeneis neucratoides Zulew, WHITEFIN SHARKSUCKER, rare, UMML.  
Phtheiroichthys lineatus (Menzies), SLENDER SUCKERFISH, rare, offshore, UMML.  
Remora brachyptera (Lowe), SPEARFISH REMORA, rare, offshore, UMML.  
Remora osteochir (Cuvier), MARLINSUCKER, frequent, offshore, UMML.

#### GOBIESOCIDAE - CLINGFISHES

+Acyrtops beryllinus (Hildebrand and Ginsburg), EMERALD CLINGFISH, occasional, UMML.  
 +Goblesox strumosus Cope, SKILLET FISH, occasional, UMML.

#### TRIACANTHODIDAE - SPIKEFISHES

Parahollardia lineata (Longley), JAMBEAU, rare, offshore, UMML.

#### BALISTIDAE - TRIGGERFISHES AND FILEFISHES

Alutera monoceros (Linnaeus), UNICORN FILEFISH, rare, offshore, UMML.  
 \*Alutera schoepfi (Walbaum), ORANGE FILEFISH, common, UMML.  
 \*Alutera scripta (Osbeck), SCRAWLED FILEFISH, occasional, UMML.  
 +Ballistes capriscus Gmelin, GRAY TRIGGERFISH, common, UMML.

- \*Ballistes vetula Linnaeus, QUEEN TRIGGERFISH, occasional.
- \*Cantherlines macrocerus (Hollard), HOOKTAIL FILEFISH, rare.
- \*Cantherlines pullus (Ranzani), ORANGESPOTTED FILEFISH, frequent, UMML.
- +Canthidermis sufflamen (Mitchill), OCEAN TALLY, common, UMML. This name differs from that of Bailey et al. (1960) in accordance with common usage.
- +Monacanthus ciliatus (Mitchill), FRINGED FILEFISH, common, UMML.
- +Monacanthus hispidus (Linnaeus), PLANEHEAD FILEFISH, frequent, UMML.
- +Monacanthus setifer Bennett, PYGMY FILEFISH, occasional, UMML.
- \*Monacanthus tuckeri Bean, SLENDER FILEFISH, common, UMML.

#### OSTRACIIDAE - TRUNKFISHES

- +Acanthostracion quadricornis (Linnaeus), COWFISH, common, UMML.
- \*Lactophrys blecaudalis (Linnaeus), SPOTTED TRUNKFISH, frequent, UMML.
- +Lactophrys trigonus (Linnaeus), TRUNKFISH, occasional, UMML.
- \*Lactophrys triqueter (Linnaeus), SMOOTH TRUNKFISH, common, UMML.

#### TETRADONTIDAE - PUFFERS

- \*Canthigaster rostrata (Bloch), SHARPNOSE PUFFER, common, UMML.
- +Sphoeroides spengleri (Bloch), BANDTAIL PUFFER, frequent, UMML.

#### DIODONTIDAE - PORCUPINEFISHES

- \*Chilomycterus antennatus (Cuvier), BRIDLED BURRFISH, frequent, UMML.  
Included by Bailey et al. (1960) but not previously recorded.
- \*Chilomycterus atinga (Linnaeus), SPOTTED BURRFISH, frequent, UMML.
- +Chilomycterus schoepfi (Walbaum), SPINY BOXFISH, frequent, UMML. This common name differs from that of Bailey et al. (1960) in accordance with common usage.
- \*Diodon holacanthus Linnaeus, BALLOONFISH, frequent, UMML.
- \*Diodon hystrix Linnaeus, PORCUPINEFISH, frequent, UMML.

#### MOLIDAE - MOLAS

- Mola lanceolata Linnaeus, SHARPTAIL MOLA, rare, offshore.
- Mola mola (Linnaeus), OCEAN SUNFISH, rare, offshore.

#### BATRACHOIDIDAE - TOADFISHES

- Opsanus beta (Goode and Bean), GULF TOADFISH, abundant, inshore.
- Porichthys porosissimus (Valenciennes), MIDSHIPMAN, frequent, offshore, UMML.

#### LOPHIIDAE - GOOSEFISHES

- Lophius americanus Valenciennes, GOOSEFISH, occasional, offshore, UMML.
- Genus sp., an undescribed genus and species, rare, offshore, UMML.

#### ANTENNARIIDAE - FROGFISHES

- +Antennarius ocellatus (Bloch and Schneider), OCELLATED FROGFISH, occasional, UMML.
- +Antennarius pauciradatus Schultz, DWARF FROGFISH, occasional, UMML.  
Not included by Bailey et al. (1960) but described by Schultz (1957) from Florida.
- \*Antennarius scaber (Cuvier), SPLITLURE FROGFISH, rare, UMML.
- Histrio histrio (Linnaeus), SARAGASSUMFISH, frequent, offshore.

## OGCCOCEPHALIDAE - BATFISHES

- +Halleutichthys aculeatus (Mitchill), PANCAKE BATFISH, abundant, offshore, occasional reef, UMML. The common name spiny batfish of Bailey et al. (1960) is inappropriate as this species is one of the least spiny of the family.
- +Ogcocephalus cubifrons (Richardson), POLKA-DOT BATFISH, occasional, UMML.
- Ogcocephalus nasutus (Valenciennes), SHORTNOSE BATFISH, rare, offshore, UMML.
- +Ogcocephalus parvus Longley and Hildebrand, ROUGHBACK BATFISH, common offshore, occasional reef, UMML.
- +Ogcocephalus vespertilio (Linnaeus), LONGNOSE BATFISH, frequent offshore, rare reef, UMML.
- Zalleutes mcgintyi (Fowler), TRICORN BATFISH, frequent offshore, UMML.

## Basic Plant and Animal Communities

The plant and animal communities of the Biscayne National Monument area are extremely rich and varied. The following discussion is limited to the dominant communities of the area. To list the species of plants and animals found in each community would be superfluous in view of the extended list of animals and plants found in the last section of this report. To use the list of animals and plants for community or ecological purposes, one should refer to the key to the zonations and ecological habitats given at the first of the list. In the following discussions, the general code number from the extended list has been put in parentheses after the headings in order that the interested reader may refer easily to these lists.

The plant and animal communities of the marine environment within the monument waters have been described in part by Stephenson and Stephenson (1950) and Voss and Voss (1955), and for details of many of these communities, these papers should be consulted. Stephenson and Stephenson worked partly within the monument area and there are many direct references to Elliott Key and Old Rhodes Key. Voss and Voss did their report upon the nearby Soldier Key, separated from the Biscayne Monument waters by a few miles of flats and coral areas. These papers deal with the intertidal area, the reef flat and the reef tract itself. For a comprehensive review of the infauna bottom communities of the mid-portion of the bay, the papers by H. Moore and his colleagues should be consulted (McNulty, J. Kneeland, Robert C. Work, and Hilary B. Moore, 1962). These community assemblages should be found in the level bottom on the bay side of the monument.

### 1. Thalassia community (Code 3).

Within the bay, the most important community is that of the turtle grass. The turtle grass community is composed of turtle grass (Thalassia testudinum), the manatee grass (Syringodium filiforme) and Diplanthera wrightii. These grasses form dense mats on the bottom, their rhizomes forming a thick mass penetrating the bottom for eighteen inches or more. Their leaves greatly increase the available surface for the attachment of various species of filamentous algae (Humm, 1964) diatoms, foraminifera, and various bivalve mollusks. The long leaves also function as a sediment trap and assist thus in maintaining water clarity. D. Moore and Work (unpublished) made a detailed study of the Thalassia community over a three year period and concluded that it supported the richest assemblage in species and number of individuals, of any known marine community. The productivity of this community is very high (see Jones, 1968) and it is the known nursery ground for the early stages of the commercial shrimps of the genus Penaeus, and the crawfish, Panulirus, as well as many species of shore fishes. The main predator is the sea urchin, Lytechinus variegatus, and certain of the parrot fishes in the vicinity of lagoon patch reefs. On the borders of the Thalassia community, several algae make inroads: Penicillus, Halimeda and Laurencia.

## 2. Bay hard bottom community (Code 9d).

Much of the deeper portion of the bay and the eastern shore against the keys is composed of a soft, calcium carbonate sediment overlaying the rock substrate. This calcium sand is in places very shallow and the whole region must be classed as hard bottom.

The most conspicuous growth forms in this region are the various sponges, especially Hippiospongia gossypina, H. lachne, Spongia barbara, S. cheiris, and S. graminia, (all commercial sponges), the loggerhead sponge, Spheciospongia vesparia, and the vase sponge Ircinia campana; the corals, Porites porites, Siderastrea siderea, S. radians and Solenastrea hyades, and the sea feathers of the genus Plexaurella and Pterogorgia anceps. This is not an area of high productivity and most of the enrichment is gained from the adjacent Thalassia beds and mangrove fringe. A considerable number of organisms live within the canals of the sponges varying in size from the large worm Eunice spongicola to thousands of snapping shrimp. The nature of these relationships has not as yet been studied. This area is important in the life histories of the crawfish Panulirus and is one of the major habitats for the stone crab, Menippe mercenaria.

## 3. Mangrove community (Code 8).

Next to the Thalassia community, this is one of the most important areas in tropical waters due to 1) its stabilization of the shore line, 2) filtering of land runoff and 3) the contribution to the organic nutrients through its leaf fall and associated organisms. This community is characterized by the three mangroves: red mangrove (Rhizophora mangle), black mangrove (Avicennia nitida) and the white mangrove (Laguncularia racemosa). Associated with these but more landward is the buttonwood (Conocarpus erectus). The plant communities of this area have been described by J. H. Davis (1940, 1942) and Craighead (1964) has discussed their relationship to land building and the effect on them of hurricanes.

On the bay side of the keys, the mangroves attain their maximum development in the monument. The most conspicuous organisms related to the mangrove community are those attached to the mangrove root props, trunks and pneumatophores. These often double the diameter of the root props themselves. These consist of the alga Bostrychia, numerous hydroids, such as Lytocarpus philippinus, encrusting sponges, coon or mangrove oysters Crassostrea rhizophorae, the pearl oyster Pinctada radiata, several species of barnacles, the snails Littorina angulifera and Tectarius muricatus, several species of small climbing crabs of the genus Pachygrapsus, the sea roach Ligia baudiniana and occasional sea urchins. Beneath the mangroves in the intertidal zone or just above can be found the gastropods Melampus, Detracia, and Truncatella and hunting in this area but living above the high tide mark, the large land crabs Ucides, Cardisoma and Gecarcinus.

#### 4. The supralittoral and intertidal.

The east side of the keys is mainly rocky in the intertidal and has been well studied in regards to its ecological zonations by Stephenson and Stephenson (1950) and Voss and Voss (1955). The Stephensons divided this region into the upper platform (from the line of land vegetation to the sea edge(?)), and the lower platform which extended from this out to the reef flat. These areas were further subdivided into color zones based upon exposure, weathering, algal mats and other factors. From the land out, these were -- upper platform (white, grey, black and yellow); lower platform (no color zones given). Voss and Voss in their study of Soldier Key did not use this color zonation but divided the intertidal into upper platform, platform face, and lower platform, features that can be seen easily in most seaward areas in the monument.

##### Upper platform.

White zone. -- This is the actual meetingplace of land and sea. It is bleached white by salt spray and no fully marine animals or marine plants live in it. Animals present are: the hermit Coenobita, the isopod Ligia, two crabs Sesarma and Cyclograpsus, and the snails Tectarius, Truncatella and Detracia.

Grey zone. -- This lies between the white and the black zones. Plants are: Sesuvium, Batis, Salicornia and others. The animals are: Littorina ziczac, Tectarius muricatus and tuberculosis, Echininus nodulosus, Nerita peleronta and N. versicolor (all gastropods), and the aforementioned crabs as well as the other organisms mentioned above.

Black zone. -- This zone is wetted at high water spring. Its black color is derived from the coloring effects of certain blue-green algae Entophysalis and Brachytrichia, and the dry mats of the alga Bostrychia. Animals in this zone are most of those mentioned above with the addition of Planaxis lineatus, a snail and the common snail Batillaria minima which may occur in vast mats.

##### Platform face (yellow zone) (Code 2).

The platform face is occupied by the yellow zone which is the true intertidal zone of the inshore. The characteristic color is given by the wet mats of algae, primarily such forms as Anadyomene stellata, Cladophoropsis membranacea, Catanela repens, Centroceras clavulatum, Ceramium fastigiatum, Polysiphonia howei. Higher up, Bostrychia and Valonia are dominant. All of these algae form dense mats that offer refuge to numerous small animals.

The animals within the yellow zone are too numerous to list here but include numerous specimens of the barnacles Chthamalus stellatus and Tetraclita squamosa, the vermetid mollusk Spiroglyphus, the false limpet Siphonaria pectinata and alternata, various fissurellids, especially Diadora listeri, the snails Batillaria minima, Thais rustica, Cantharus tinctus, the true limpet Acmaea and the slug Onchidium floridanum. The

large chiton, Acanthopleura granulata, is common along with the mussel Mytilus exustus and the oysters Isognomon alata and I. chemnitziana. Numerous other animals are found in this zone. They are listed in the species lists.

#### 5. Shallow water.

##### Lower platform (Code 2)

The lower platform is difficult to separate from the so-called reef flat. It begins at the bottom of the platform face. It is often distinguished by the somewhat steeper slope, very rough eroded stone floor, and the presence of most of the area of the yellowish-green carpet of Laurencia papillosa and associated green and red algae. Dominant in many places in holes in the rock is the sea urchin Echinometra lucunter, the mussels Arca barbata and A. umbonata. Several anemones are found here, Phymanthus crucifer, Aiptasia annulata and Condylactis gigantea. Many species of crabs are found under rocks in this area. For a more complete listing, see the species list.

##### Reef flat (Code 5, 9, 10)

This is a general term that takes in the entire area east of the keys except the reef itself. Distinct communities have not been recognized in that area except for the extensive Thalassia community already mentioned, and the lagoon patch reefs and the outer reef. These will be treated separately.

#### 6. Lagoon patch reef (Code 7).

One of the most prominent features found within the Hawk Channel is the lagoon patch reef. These are found around Bache Shoal, Margot Fish Shoal, and back of Triumph Reef, Long Reef and Ajax Reef. These reefs have been studied in detail by Voss and Bayer (1968), Jones (1963), and Ebbs (1966).

Commonly, the patch reef is a structure formed of living masses of coral heads rising directly from the bottom in 10-20 feet of water. They have nearly perpendicular sides and rise to within two or three feet of the surface. The bottom around them is usually flat and covered with Thalassia except for a ring, several yards wide, of clear sand caused by the grazing of parrot fishes. The patch reefs in the monument area range in size from individual coral heads to masses several hundred feet across.

The mass of the reef is made up of corals, primarily Diploria, Eusmilia, Isophyllia, Montastrea, Porites and Siderastrea, with associated Acropora cervicornis, Agaricia, Dichocenia, and others. These corals are usually compacted and often filled in between with coral rubble forming a reef top on which grow a profusion of sea feathers, whips and fans, of which the genera Eunicea, Muricea, Plexaura,

Pseudopterogorgia, and Gorgonia are the most common. In these patch reefs mollusks are not common except for the stubby coral shell Coralliophila abbreviata and its relatives, and a few cowries (Cypraea) and smaller forms. The crawfish or spiny lobster, Panulirus, is common.

The main body of these patch reefs is often soluted away by the waves' action and sea water to form caverns and chambers which are filled with a large number and variety of reef fishes. These are not obvious on first examination for during the day most of them will be within the reef. In fact, these reefs support a dual population of fishes, day feeders and night feeders. These are reported upon by Starck (1968), Randall (1968) and Voss and Bayer (1968).

#### 7. Outer reef. (Code 6).

The outer reefs consist of those coral reefs or dead coral reef jumble lying on the outer edge of the reef platform immediately adjacent to the drop-off into deep water and the Florida Current. These reefs have been well described by Ginsburg and Goreau (the latter not listed as the work was done in Jamaica) and the various reef types are well known.

Two main outer reef types occur in the monument waters, Long Reef and Ajax Reef. Long Reef is a low, long, shallow structure formed by loose, coral rock and sheets of dead Acropora. Within this reef structure and beneath the rock slab exists a wealth of marine life far too numerous to list here. A comprehensive listing of these species is found in the species list. Ajax Reef is a live coral reef largely made up of living Millepora colonies. The invertebrate life is not rich but numerous fish species are found. For a good description of this type of reef, see Starck (1968) who reported upon a similar structure at Alligator Reef.

## Bottom Community Chart.

Past workers (e.g., Kumpf and Randall, 1961; MacIntyre, 1968) have had moderate success making simple bottom community charts of the major faunal elements in limited geographical areas. We have attempted to make a similar chart covering the entire area of the proposed Biscayne National Monument. Of necessity, the resultant chart is to a very large extent a simplified generalization. In those areas where sharp boundaries occur between major bottom types, such as along the eastward side of the monument, the chart rather accurately portrays the natural situation. But in many areas, such as Biscayne Bay itself, the bottom types gradually grade from one into another, or two or more types may occur intermixed over large regions. In such cases, the limits portrayed are largely arbitrary. In reality, the environment is much more complex than can be shown on any chart or map. In particular, the increased complexity resulting from (1) the much larger area considered, (2) the involved interactions between the sea-land areas, and (3) the semi-closed system of Biscayne Bay itself, has created conditions that do not permit the precise delimitation of faunal boundaries commonly expected of a community chart.

Southern Biscayne Bay, the portion of the bay incorporated into Biscayne National Monument, is a large shallow estuary bounded on the north by the shallow Featherbed Banks, to the south by Cutter Bank, to the east by the chain of islands from the Ragged Keys to Old Rhodes Key and to the west and southwest by the mainland coast. Water circulation is somewhat restricted by the land masses. Flushing occurs through a number of deep channels or cuts directly to the ocean (eastward), to north Biscayne Bay and to Card Sound on the south; the primary cause of the water exchange is tidal flushing.

In conjunction with the restricted circulation, the southern part of Biscayne Bay is subject to a variable input of fresh water from many drainage canals along the mainland and subsurface fresh water percolation (Kohout and Kolipinsky, 1964, and personal observations).

These conditions cause extremes of temperature and salinity -- both high and low -- not found in the oceanic environment. They also contribute to the complexity of the bottom communities within the Bay. In addition, the bottom of the Bay itself is of primary importance in determining the faunal make-up. The Bay is underlain by a limestone rock bottom that is generally covered by small but varying depths of sand or silt. Even small changes in thickness of sediment influence the bottom communities immensely, with the marine grasses (primarily Thalassia testudinum) and certain algae (e.g., Penicillus) dominating regions of thick sediment (e.g. 10 cm. or greater), and sponges, alcyonarians, and other algae dominating regions of thin or no sediment.

Because of the diversity of conditions in Biscayne Bay, the bottom communities are diverse and their interrelationships complex. Eight different environmental types are distinguished on the chart: (1) marine

grasses; (2) algae; (3) sand; (4) sponges and alcyonarians; (5) bare rock; (6) corals; (7) coral rubble; and (8) mangrove.

The dominant bottom community throughout the monument is that characterized by the marine grasses. Thalassia testudinum is the most common component, but it is replaced by or found mixed with Syringodium filiforme in the deeper waters and Diplanthera wrightii in shallower regions. The Thalassia community actually can be further divided into separate sub-communities. In some regions, especially the area east of the chain of islands, dense beds of almost pure grasses dominate. In other regions the grasses grow less thickly, and the bottom is greatly worked over by burrowing polychaetes. Algae can invade the grass beds to a varying extent: Penicillus and Halimeda are two common forms, and Laurencia first mixes with, then replaces the grasses along the western shore of the Bay. The chart makes no attempt to separate the different species of marine grass, nor does it indicate the concentration of the grasses.

Although some algae (Penicillus and Halimeda) are found in deeper (10 m) waters mixed in with the grasses, the algae as a dominant bottom community are restricted to shallow waters. They occur primarily in belts immediately surrounding the shore of the mainland and the islands, although Laurencia is the dominant cover over a large segment of the southwest section of Biscayne Bay.

The regions indicated by sand likewise include more than a single type of bottom community. In the area to the east of the islands, between the thick Thalassia beds and the outer coral reefs, a region of isolated sand patches occurs. These range in size from quite small (a few meters) to several kilometers in length. They are quite clearly defined by a sharp, usually undercut border between the sand and the grasses. Generally no vegetation occurs in these sand patches. The sand is a fairly coarse, calcareous sand. In contrast, regions within the Bay that are similarly designated on the chart are not so clearly defined; their delimitation has necessarily been arbitrary, because of their indistinct boundaries. Actually Thalassia is found in varying densities, over almost the entire bay floor. It is concentrated in discrete dense patches, which are often distributed in irregular lines, and is found in sparse growth over the remainder of the bottom. There is an even continuum from dense Thalassia growths to the sparsest regions, and the line delimiting a predominantly sandy area from a predominantly grassy one is indeed arbitrary, although the authors believe, in view of the great differences between the types of bottom, that the distinction should be made. In addition to grass, the sandy areas of the Bay also contain many sparse patches of sponges and alcyonarians; again the delimitation is an arbitrary one.

A third type of sandy area, not shown on the chart, is a sandy halo surrounding the many coral patches in the zone to the east of the islands. This halo is a narrow belt of sand that surrounds virtually every patch reef and is considered to be the result of grazing by reef fauna.

Sponges and alcyonarians are found widespread over much of the monument area. Dense stands occur in the cuts between the islands, where swift currents flow. Sparse growths are found around the islands themselves and throughout the Bay as well. Sponges and alcyonarians, especially the latter, are also important components of the coral patches in the zone to the east of the islands; in this community they are included in the symbol for corals, and are not marked separately.

Patches of the limestone base emerge as bare rocks in some regions, primarily in the surf zone around the islands. In addition to supporting a distinct community, these regions are noteworthy because the rock is greatly eroded and pitted by solution, forming a very sharp, hard substrate that should be avoided by waders and boaters.

Although some corals (e.g., Porites, Manicina, and Siderastrea are scattered throughout the monument area, large coral patches are found in only in two zones. Seaward of the dense Thalassia zone to the east of the islands is an area of dense but discrete coral patch reefs. In addition to large coral heads, these patch reefs also include dense growths of alcyonarians and sponges. Some of the patches, especially in the Margot Fish Shoals, contain large patches of Acropora cervicornis, but this is not really widespread. The patch reefs are scattered throughout a matrix of rather dense Thalassia; they do not form a solid bottom cover.

A zone of outer reefs is located still farther to the east. This is largely an area of dead reefs (indicated by coral rubble) although there is some living coral in this region. Only in the southern end of the outer reef -- around Pacific Light -- do large, luxuriant growths of corals, primarily Acropora palmata, occur.

Finally, in many regions around the islands and along the mainland, mangroves extend for varying distances into the water. This is a distinctive community subject to rather sharp delineation and therefore portrayed accurately on the chart.

Considering all of the zones, the following can be summarized: generally, proceeding from the shore (either mainland or islands) seaward, one passes from either mangroves or bare rocky coast successively through an algal zone, a sparse alcyonarian-sponge zone, and a marine grass zone. The relative extents of these zones are influenced at least partially by depth, bottom type, and salinity. Finally, east of the islands, a coral patch reef zone, a sand patch zone, and a barrier reef coral rubble zone are encountered. The dominant feature of the Bay itself is the large central sand zone with scattered Thalassia, alcyonarians, and sponges. The most prominent features outside the Bay are the dense beds of Thalassia and secondarily the coral patch zone.

## Seasonal Abundance and Migratory Patterns of Marine Life.

Tropical waters do not have a great seasonal range of temperature and as a result there are few evident seasonal migrations or movements of the fauna. Those migrations that do take place are usually feeding migrations involved in the life history of the species. A few of the larger, more active long-ranging swimmers do show seasonal changes. These will be mentioned below. In general among many of the tropical fishes and invertebrates, spawning is not restricted to a few days or a week or two as in temperate regions but may take place over a period of several months or even throughout the year. As a result, great increases in seasonal abundance are not generally seen. Long-term spawning periods also are important for management practices, in that distinct year classes are not common in tropical forms, and adverse weather conditions do not noticeably affect the year's production of young.

Plants. The life histories of few of the marine plants of the region are known. Because of the rather small seasonal variation in water temperature, and especially the lack of any period of extreme low temperature, there is typically no period in the year when the majority of adult marine plants disappear. However, some types of algae, for example, the various species of Caulerpa, may show periods of flourishing vegetative growth as well as periods of inactivity when outward signs of the vegetative plants regress or even vanish. Such individual seasonal responses, however, have little effect upon the appearance of the marine flora.

The most prominent seasonal change in the plants is seen in Thalassia, which may suffer heavy loss of leaves during the brief periods of winter low and summer high temperatures. This marine grass and the larger green, red and brown algae may be covered over by a mat-like growth of blue green algae during the summer in semi-stagnant areas.

Invertebrates. There is little change in seasonal abundance of most invertebrates and these are minor. Only a few cases of seasonal migration are known.

1. There is some change in the abundance of Octopus. In general, adult octopus move offshore during the summer into waters of 15-30 ft. depths, but in winter and spring they come inshore to spawn and to find warm water. Most species are common in depths of less than 10 ft. during the period from March to May when they are caring for their eggs under old coral heads and rock slabs.

2. Lower Biscayne Bay and Card Sound are important nursery grounds for the pink shrimp, Penaeus duorarum Burkenroad. Spawning takes place in deep water offshore. The larval shrimp begin to appear in the Bay in quantity in March where they live in shallow water of 2 ft. depth or less. They grow rapidly in this nursery ground and by September they have reached a fairly large size and have moved out into the Bay into waters

deeper than 3 ft. where they are fished for in the bait shrimp fishery. These shrimp remain in the Bay as juveniles where they attain a considerable size. However, no adult gravid shrimp have been taken in the Bay. About the end of December, depending upon weather conditions and moon phase, the juvenile shrimp move out of the Bay into the ocean. According to recent studies, this movement in the main is northward in the Bay and the majority of the shrimp pass out through Cape Florida Channel, Bear Cut and Government Cut. Despite these migrations, there are always juvenile shrimp in the Bay, to the extent that the bait shrimp fishery flourishes. For some reason not now understood, there is a migration into the Bay of the Caribbean Brown shrimp (Penaeus brasiliensis) in the summer when, for several months, it accounts for up to 40 per cent of the bait catch. It is not found in the Bay during the rest of the year.

3. The spiny lobster, mainly Panulirus argus Latreille, also performs a general growth movement. The larvae hatch out as phyllosomas and remain drifting passively in the plankton for up to 5-6 months. After metamorphosis, the very young juvenile spiny lobsters are found in the grass beds in shallow water in the Bay, especially on the western side and on the east side of the Keys. With about 1/3-1/2 growth they are found in deeper water in the Bay living under sponges, particularly the logger-head sponge Spheciospongia vesparia. As adults they are found in water of four feet or greater depth, living in rocky holes, under rocky or coral ledges, and various other sheltered situations. At certain times and places, particularly along the open ocean beach, spiny lobsters perform long mass migrations. Neither the cause, time nor duration are known. No such mass migrations have so far been reported from the monument region.

Fishes. There is extensive movement of fishes within the Park area, much of which can be termed migration. Migrations are of three main types: 1) daily, 2) seasonal, 3) ontogenetic. Daily migrations are practiced by many of the so-called reef fishes and are usually associated with nocturnal feeding activities in the grass beds and open sand areas. Most grunts (Pomadasyidae) and snappers (Lutjanidae) which account for much of the mass of fishes to be found on the reefs by day undergo such migrations.

Seasonal migrations are of two types. One is associated with spawning and mostly consists of estuarine, bay and reef species that move offshore to spawn. The time and length of the spawning season varies with the species. The American eel moves on particular moon phases especially in the December and March season. Worm eels move again during particular moon phases most every month. Other notable migrants of this type within the park are the mullets (especially in November and December), the jack-knife fish, the black grouper (probably all groupers).

The second group of seasonal migrants are fall and winter visitors from the north. Most important here are the smooth hammerhead, the black-tip shark, certain rays and the bluefish.

Ontogenetic migrants are those that spend their juvenile life within the area, moving with growth into offshore waters or at least to a differ-

ent habitat within the Park.

Jackknife fish -- Young on the deep reef, adults in the Bay and mangroves.

King mackerel -- Young in the Bay and grassy areas, adults oceanic.

Grey snapper -- Young in grass beds, adults on outer reefs and in passes.

Striped mojarra -- Larvae oceanic, juveniles along the shore, adult estuarine.

The larvae of many but not all shore and reef fishes are oceanic. Life histories of only a few are known in detail. In some, spawning takes place in shore waters with the eggs being swept out to sea. In others, hatching also occurs in inshore waters with the early larvae going to sea while in others the adults move offshore to spawn.

Of the many fish species known within the monument, only certain reef species spend their entire life in a single environment. Of all phases of study needed on monument fishes, none is more deserving from a resource management standpoint than basic life history studies.

The Florida Keys form a crescentic chain of small limestone islands which extend from near Miami in the north to, and including, Key West on the south and west, a total of about 150 miles. They form an arc bounded on the convex side by the Florida Current and on the concave side by Biscayne Bay, Florida Bay and adjoining waters. Basically they are made up of two main formations of Pleistocene age -- the Key Largo Limestone and the Miami Limestone. The former is an elevated coral reef rock and the latter an oblitic limestone. The Key Largo Limestone is the surface rock of the upper Keys, and the Miami Limestone covers the Lower Keys. Actually, the Key Largo Limestone covers the entire 150 miles of the Florida Keys but in the Lower Keys is overlain by the Miami Limestone beginning near the east end of Big Pine Key.

The Key Largo Limestone first appears at the surface near its northern boundary at Soldier Key just north of the Ragged Keys and forms the basis of the main keys contained within the monument. It is especially conspicuous as eroded ragged rock along the ocean side of the keys with major outcrops at Caesar's Creek and Old Rhodes Channel. It also forms the hard, smooth floor of several of the passes where the tidal current keeps sediments scoured away.

According to drillings investigated and/or made by Hoffmeister and Multer, this limestone rests upon a quartzose calcareous sand base. The limestone is of varying thickness; near the northern end of Key Largo it was 145 feet thick, 10 miles further south 75 feet. In the lower Florida Keys it attains a thickness of nearly 200 feet. It is typical organic reef composed of in situ, wave resistant elements, the important of which are hermatypic corals. These form the framework of the structure and are responsible for the trapping of large amounts of calcarenite in which

they are now embedded. The formation is made up of these lithologic types (in order of decreasing abundance): calcarenite, coralline limestone, and calcilutite.

1. Calcarenite. This rock consists of varying amounts of molluscan debris, Halimeda, coralline algae, foraminifera, bryozoans, coral and rock fragments bounded by microcrystalline and sparry calcite. Minor constituents include pellets, echinoid spines, sponge spicules, ooliths and worm tubes.
2. Coralline limestone. Large masses of coral, either in growth position or as detached fragments, recrystallized to calcite occur. The principal corals are Montastrea annularis, Diploria strigosa, D. clivosa, D. labyrinthiformis, and several species of Porites, principally P. astreoides. This limestone can be porous or dense, commonly with burrows of boring mollusks, the cavities often lined with drusy calcite or filled with varying amounts of sand-size debris. About 30 per cent of the Key Largo Limestone is made up of this coral rock of which Montastrea makes up about half. Acropora cervicornis, Montastrea cavernosa and Siderastrea radians are also found in lesser amounts. All of these corals are found living today within the monument boundaries.
3. Calcilutite. This dense rock made up of well-cemented silt-clay carbonate commonly displays pinpoint-to finger-size holes. Limited amounts of skeletal hash are often present.

The coral rock where exposed has a thin cap of very hard rock overlying it, formed either by aerial exposure or microbial activity. It is extensively quarried for use in decorative walls and in floors and patios in south Florida. In situ, below the hard cap, it is soft, and well points pierce it easily. Upon lengthy exposure it becomes very hard and durable. Quarries are found throughout the Keys.

The method of formation of the Keys themselves has been a matter of controversy, some claiming that the present keys represent the limits of a former outer coral reef of Pleistocene times, others claiming that they were formed from lagoon patch reefs in the back-reef area when the outer reef was located some distance inshore of its present position. Studies by Hoffmeister and Multer (loc. cit.) point to the latter hypothesis. They say:

"During the last interglacial period, about 95,000 years ago (Broecker and Thurber, 1965, pp. 58-60), the coral reefs which today make up the Key Largo Limestone of the Florida Keys were flourishing as a line of patch reefs in the back-reef area of a broad-reef platform similar to the Florida reef tract of today. Seaward of them the platform was occupied by parallel lines of other patch reefs and edged by an outer reef (Fig. 2).

"Subsequent marine and subaerial erosion following the withdrawal of the sea during the Wisconsin, possibly accompanied by a structural downwarping or tilting or faulting of the area, or both, resulted in the lowering of the

platform to a depth of about 75 feet at its seaward edge and progressively less farther inland. With the return of the sea, new reef growth began on the eroded platform and continued to the present (Fig. 3).

"Some of the main observations upon which it is concluded that the Key Largo Limestone of the Keys originated as a line of patch reef in a back reef environment are the following. (1) The species of corals and other organisms found fossil in the old reef are identical with those of the living patch reefs. (2) There is an absence of Acropora palmata, a coral species found commonly in the turbulent waters of living outer reefs. (3) There is a favorable proportion of other species common in all zones. (4) Since the community of coral species found in the Key Largo requires an environment of low-level energy and since it was determined that the water in which the corals grew was shallow, it becomes clear that they must have developed in the protected area of a back reef zone. (5) The discovery of Acropora palmata in the Key Largo Limestone, underlying the more recent material of the outer reef, demonstrates its presence at the time the Keys were being formed and indicates that its absence in the rocks of the Keys is due to the unfavorable environment of a back reef. Its presence also indicates the existence of an outer reef at the edge of the platform during Key Largo time. (6) The elongated crescentic shape of the Keys, running approximately parallel to the outer edge of the platform, is similar to the alignment of present day patch reefs."

The soil of the Keys, overlying the Key Largo Limestone, is of organic origin, originally from materials trapped in the outcroppings but now mainly muck or humus from the hardwood hammocks and mangrove peat.

Offshore of the Keys, the bottom is underlain by Key Largo Limestone with a layer of post-Pleistocene Key Largo Limestone overlying the older rock and increasing in thickness seaward. Upon this is a layer of calcium carbonate sediments made up of mechanically precipitated fine calcium carbonate, and fine particles of calcium carbonate shells of a host of marine organisms such as Halimeda segments, sea-urchin spines and ancyonarian spicules, and the shells of Foraminifera. The outer reef base is of post-Key Largo Limestone formation overgrown in large areas by stands of living coral. The lagoon and back-reef area is thickly interspersed with patch reefs such as those forming Bache Shoal, Margot Fish Shoal, and the lagoon reefs behind Long Reef.

Shoreward of the reef, the bottom is formed basally of Key Largo Limestone overlaid by soft calcium carbonate mud or ooze, thick in the western half of Biscayne Bay, but thin the eastern half.

A short but pertinent bibliography of sources concerning the geology pertaining to the monument area is given at the end of the report.

A more detailed geological description of the coral reefs is given in the following references:

- 1967- Miami Limestone of Florida and its Bahamian Counterpart. Geol. Soc. Amer. Bull., 78:175-190. K. W. Stockman and H. G. Multer
- 1968-Geology and Origin of the Florida Keys. Geol. Soc. Amer. Bull. 79:1487-1502. H. G. Multer.